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ERRATA

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For

"Fig. 1: Distribution of *Apus acuticauda*. 1. Nepal; 2. Type locality: Bhutan; 3. Samdrup Zongkhar, 4. Cherrapunjee, 5. Blue Mountain and Tlungvel, 6. Khonoma; Thailand; Chang Mai Province."

Read

"Fig. 1: Distribution of *Apus acuticauda*. Nepal: 1. Type locality; Bhutan: 2. Samdrup Zongkhar; India: 3. Cherrapunjee, 4. Blue Mountain and Tlungvel, 5. Khonoma; Thailand: 6. Chang Mai Province."

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Editorial

Ramsar Convention: A tool for wise use of wetlands

Wetlands are transitional areas between aquatic and terrestrial ecosystems where the water table is usually at or near the surface, or the land is covered under shallow water. Wetlands include marshes, swamps, flood plains, bogs, peat lands, shallow ponds, littoral zones of larger water bodies, and tidal marshes. Wetlands are very diverse, but they all share one fundamental feature: the complex interaction of their basic components — soil, water, animals and plants — that fulfil many functions and provide many products that have sustained humans over the centuries (Wetlands International 2002). Of course, not every wetland performs all these functions, but most do.

In India, wetlands are distributed in all the biogeographic regions and exhibit significant ecological diversity, primarily because of the variability in climate, geology, habitat and topography. Wetlands provide a multitude of services, including water purification and regulation of flows, fisheries, habitats for plants, animals and micro-organisms, opportunities for recreation and tourism, and so forth (Wetlands International 2002).

The Ramsar Convention came into force in 1975; there are 157 Contracting Parties. In all, 1,704 wetland sites have been designated as Ramsar sites, with a total area of 152 million hectares (www.ramsar.org). India became a Contracting Party to the Convention in October 1981, and designated the Chilika Lake (Orissa) and the Keoladeo National Park (Rajasthan) as its first two Ramsar sites. Four additional sites were designated in 1990: Sambhar Lake (Rajasthan), Loktak Lake (Manipur), Harike Lake (Punjab), and Wular Lake (Jammu & Kashmir). In 2000, the Ministry of Environment and Forests, Government of India, identified 13 new wetlands and designated them as Ramsar sites. The decision came in the wake of the announcement by the Government at the 7th Conference of the Parties to the Ramsar Convention (COP7) held at San Jose (Costa Rica) in May 1999. In 2005, six more sites were designated as Ramsar Sites. At present, 25 wetlands have been designated as Ramsar sites in India. However, these 25 Ramsar sites do not represent even a fraction of the diversity of wetland habitats existing in the country.

In India, the Ministry of Environment & Forests (MoEF) is the nodal agency for implementing the conservation programme on wetlands, mangroves and coral reefs. Started in the 1980s, the programme is guided by a National Committee on Wetlands, Mangroves and Coral Reefs, constituted to advise the government on appropriate policies and programmes for the conservation of these ecosystems, to suggest specific sites for conservation action, and to identify research and training priorities. Several wetland sites in the country have been selected on a priority basis for conservation and management action, financial support for which is being extended by the Ministry (MoEF 2001).

Ten biogeographic zones have been identified in India: Trans-Himalaya, Himalaya, Semi-arid, Desert, Gangetic Plain, Deccan, Western Ghats, North-east, Coasts and Islands (Rodgers and Panwar 1988). The wetlands in the Trans-Himalaya are extremely important for the protection of birds, especially for globally threatened species such as the Black-necked Crane *Grus nigricollis*.

Some of the important high altitude lakes such as Tso Kar, Tsomoriri, Pangong Tso, and marshes such as Hanley, Phoktsey and Chushul, are located in this region; most of them have been identified as IBAs and potential Ramsar Sites.

The Gangetic Plain is one of the most fertile regions of the world, with a nearly 3,000 year history of human occupation. This region is famous for its flood plain wetlands — results of copious rainfall in the Gangetic Plain and also in the Himalaya from where most of the rivers originate. Large areas are annually flooded and when the flood recedes, it leaves low-lying areas under water. These wetlands are extremely productive in terms of vegetation biomass and avian diversity (Howes 1995). Some of the most important wetland IBAs and potential Ramsar Sites are found in this region with significant populations of waterfowl. Sultanpur in Gurgaon, Bhindawas in Rohtak, Patna *jheel* in Etah, Lakh-Bahosi in Farrukhabad, Saman in Mainpuri, Sandi in Hardoi, Kawar in Begusarai and Nawabganj in Unnao, are some of the more spectacular wetlands for migratory waterfowl in winter. The marshes

and wetlands of the Gangetic drainage system show a long history of stability in the geological sense. Thus, a large number of marsh-dependent species are found such as the Striated Marsh Warbler *Megalurus palustris*, Bristled Grassbird *Chaetornis striatus*, Rufous-rumped Grassbird *Graminicola bengalensis*, Yellow-bellied Prinia *Prinia flaviventris*, Swamp Francolin *Francolinus gularis*, Bengal Florican *Houbaropsis bengalensis* and a variety of ducks.

The flood plains of the Brahmaputra and the marshes and swamps in the hills of north-east India and the Himalayan foothills are important for humans and biodiversity. The Brahmaputra Valley, with its high rainfall and numerous rivers provide wintering grounds to large congregations of waterbirds. Most of these waterbirds are migratory while some are resident and breed in this region. The wetlands of this region support a number of threatened species; a number of IBAs and potential Ramsar Sites have been identified in this region.

In the Rann of Kutch in Gujarat, vast saline expanses are found where both Greater *Phoenicopterus roseus* and Lesser *P. minor* flamingos breed when conditions are suitable. The wetlands of the Deccan peninsula support a high proportion of the global population of the Spot-billed Pelican *Pelecanus philippensis*, with many colonies associated with the water storage reservoirs or 'tanks' on the Deccan plateau in southern India. The coastal areas of India perhaps form the most neglected biogeographic zone of India, mainly because they do not have charismatic species such as the Tiger and the Rhinoceros. However, they do have fabulous bird congregations, as seen in the Chilika Lake (IBA and Ramsar Site) and Bhitarkanika (IBA and Ramsar Site) in Orissa, the Point Calimere Wildlife Sanctuary (IBA and Ramsar Site) in Tamil Nadu, the Sunderbans (IBA and Ramsar Site) in West Bengal, the Sewri mudflats (IBA and potential Ramsar Site) in Maharashtra and the Kori Creek in Gujarat.

The existing Ramsar site list of 25 sites in India clearly proves that all the biogeographical regions of India are not properly represented, and some of the potential sites are missing, e.g. many important sites in the Gangetic Plain, North-east, Semi-Arid, Desert and Deccan. Under the Important Bird Areas Programme of the BNHS and BirdLife International we have prepared a list of additional 135 wetlands which are potential Ramsar Sites. This exercise is done objectively taking into consideration IBA and Ramsar criteria. We have identified potential Ramsar Sites mainly based on their biodiversity values, which was the original aim of the Ramsar Convention. We have also tried to cover the whole country and all biogeographic regions and their provinces.

We hope that many of these potential sites will be considered by the Government of India under the Ramsar Convention.

ASAD R. RAHMANI
ZAFAR-UL ISLAM

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RECENT CHANGES IN POPULATIONS OF RESIDENT *GYPS* VULTURES IN INDIA[1]

V. Prakash[2,6], R.E. Green[3], D.J. Pain[4,12], S.P. Ranade[2,7], S. Saravanan[2,8], N. Prakash[2,9], R. Venkitachalam[2,10], R. Cuthbert[4,13], A.R. Rahmani[2,11] and A.A. Cunningham[5]

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Nine species of vultures are recorded from the Indian subcontinent. The populations of three resident *Gyps* species, namely Oriental White-rumped Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus* and Slender-billed Vulture *Gyps tenuirostris* crashed during the mid nineties of the last century. Vulture declines were first documented at Keoladeo National Park, Bharatpur, Rajasthan. Subsequently, the crash in populations was documented across the country.
During the present study, surveys on identified tracks were done in 2007 to repeat surveys done previously in 1992, 2000, 2002 and 2003. This was done to determine the population trend in the three species of vultures and also to get a rough estimate of the surviving population of vultures in 2007. The latest repeat surveys were carried out from March to June 2007 by driving in a motor vehicle and recording vultures within 500 m on either side of each transect.
The results indicate that the population of the three species of vultures continues to decline at an alarming rate. Numbers of Oriental White-rumped Vulture declined by 99.9% between 1992 and 2007 on the transects surveyed each year during that period. The equivalent decline in the combined total of *Gyps indicus* and *G. tenuirostris* was 96.8%. The population of Oriental White-rumped Vulture has an average annual rate of decline of 43.9% between 2000-2007, whereas the combined average annual rate of decline of *G. indicus* and *G. tenuirostris* is over 16%. A complete ban on the use of diclofenac in livestock and the establishment of conservation breeding centres are suggested to prevent the extinction of these three species of vultures.

Key words: Oriental White-rumped Vulture, Long-billed Vulture, Slender-billed Vulture, annual rate of decline, population estimates, diclofenac, extinction, conservation breeding

INTRODUCTION

Nine species of vultures are recorded from India of which five belong to the genus *Gyps* (Prakash 1999). Three *Gyps* vultures, namely, the Oriental White-rumped Vulture (OWRV) *Gyps bengalensis*, Long-billed Vulture (LBV) *Gyps indicus* and Slender-billed Vulture (SBV) *Gyps tenuirostris* are residents, and the remaining two, the Eurasian Griffon *Gyps fulvus* and Himalayan Griffon *Gyps himalayensis* are largely wintering species (Prakash *et al.* 2003). OWRV and LBV were abundant across large parts of India until the 1990s. The SBV, which was not distinguished as a separate species from LBV until recently (Rasmussen and Parry 2001), was also locally common in north and north-eastern parts of the Indian subcontinent (Ali and Ripley 1983). During the 1980s, OWRV was thought to be the commonest large bird of prey in the world (Houston 1985). *Gyps* vulture densities were so high in some areas that they were considered a hazard to aircraft (Grubh *et al.* 1990). This abundance was the result of plentiful food supply, in the form of carcasses of domesticated ungulates. The keeping of livestock for milk production is common in rural areas, and cattle are abundant in many towns and cities. In large parts of India, Hindu beliefs prohibit the slaughter of cows and consumption of their meat. Dead feral and domestic cows are left in the open in rural areas or disposed of in carcass dumps around towns and cities (Prakash *et al.* 2003). Whilst vulture populations were able to exploit the large amounts of food available, Indian society benefited from the rapid and hygienic removal of dead livestock by vultures, a flock of which can pick a cow carcass clean in a matter of minutes (Ali and Ripley 1983).

The population of resident *Gyps* vultures in the Indian subcontinent crashed during the 1990s. This was first reported in the media in 1996-97 and later documented by the Bombay Natural History Society (BNHS), whilst monitoring raptor numbers in Keoladeo National Park, at Bharatpur in Rajasthan

(Prakash 1999). The BNHS conducted nationwide raptor surveys in many parts of India between 1991 and 1993 using a road transect method (Samant *et al.* 1995). The survey was repeated in 2000 and the results were dramatic. Both OWRV and LBV had almost disappeared from the areas surveyed. The populations of OWRV and LBV had declined by more than 92% between 1991-93 and 2000 (Prakash *et al.* 2003; 2005). Repeat surveys (in 2002 and 2003) showed that between 2000 and 2003, average annual decline rates were 48% for OWRV and 22% for LBV (Green *et al.* 2004). SBV and LBV were considered, and counted, as one species until the 2002 count, when SBV was found to comprise less than 2% of the combined total of LBV and SBV (Green *et al.* 2004). Results from the 2002 and 2003 counts suggested that the population of SBV was declining in India at approximately the same rate as the other two species.

In the Punjab province of Pakistan, an annual population decline rate of 50% was reported for breeding pairs of OWRV in nesting colonies between 2000 and 2003 (Gilbert *et al.* 2004; 2006; Green *et al.* 2004). Monitoring of nesting LBV in Sind province, Pakistan (Gilbert *et al.* 2004), showed that the numbers there had declined by about two-thirds between 2002 and 2006; an average annual decline rate of 25% per year (AVPP 2007). These results indicate that in both India and Pakistan, LBV has declined at a slower rate (22% and 25% per year respectively) than OWRV (48% and 50%). All three resident *Gyps* spp. in India are now listed as critically endangered by the IUCN.

The veterinary use of the non-steroidal anti-inflammatory drug (NSAID) – diclofenac – in livestock is the main, and perhaps the only, cause of the population declines (Green *et al.* 2004; Oaks *et al.* 2004; Shultz *et al.* 2004). Vultures are exposed to toxic levels of diclofenac when they feed on carcasses of livestock which have died within a few days of treatment, and which contain residues of the drug (Oaks *et al.* 2004). Vulture that consumes sufficient tissue from such carcasses die from the effects of diclofenac induced kidney failure. Green *et al.* (2004) estimated that no more than 0.8% of ungulate carcasses available to foraging vultures would need to contain a lethal dose of diclofenac to have caused the observed population declines. Schultz *et al.* (2004) found that a high proportion of Oriental White-rumped and Long-billed vultures found dead in the wild had severe visceral gout, consistent with diclofenac poisoning being the main or sole cause of the population declines. The license to manufacture the drug diclofenac was withdrawn by the Drug Controller General of India via a letter dated May 11, 2006 addressed to all the State Drug Controllers. The toxicity of diclofenac to vultures and the strong evidence of its effect on their populations were the reasons for withdrawal.

In this paper, we report the results of surveys across much of India during March to June 2007, which follow the same methods and transects as those used during 2003, 2002, 2000 and 1992. We use these results to estimate the present population trend of the three critically endangered species of *Gyps* vultures and to make a rough assessment of the number of vultures which might remain.

METHODS

Vulture surveys

In 2007, vultures were counted on road transects widely distributed across northern, central, western and northeastern India. Transects were positioned in and near protected areas and also along roads distant from protected areas. The core set of transects repeated a survey carried out in 1991-1993, but additional transects were added during further surveys in 2000, 2002 and 2003. The first set of surveys, carried out during 1991-1993, will be referred to as the 1992 surveys for brevity. Routes followed in 2007 were the same as in previous surveys. Each transect was driven in a motor vehicle by a driver and observer, and vultures seen by the observer within 500 m on either side of the route were recorded. Vultures were identified to species, but *Gyps indicus* and *G. tenuirostris* have only been separated recently. Hence, the 1992 and 2000 counts do not distinguish between these two species, whereas the 2002, 2003 and 2007 surveys record them separately. In the 1992 surveys, only vultures in groups of five or more were counted because they were so numerous then, but in 2000, 2002, 2003 and 2007 all vultures were recorded. Transects were driven between March and June. The numbers of transects surveyed in 1992, 2000, 2002, 2003 and 2007 were 92, 98, 159, 149 and 165 respectively. The total length of transects driven in 2007 was 18,884 km. Further details of the methods are given by Prakash *et al.* (2003) and a map showing the area in which transects were carried out is in Green *et al.* (2007).

Estimates of population trend

Not all transects were surveyed in all years. Some transects were only surveyed for the first time after several previous surveys had been carried out elsewhere, some ceased to be surveyed after a few years of coverage and some had gaps in coverage. For this reason it is not possible to estimate changes in population by comparing the total number of vultures counted on all surveys across years. Furthermore, it is also not desirable to compare numbers of vultures seen per kilometre of transect across survey years because vulture density varies substantially geographically and the composition of the sample of transects changes over

time. We adopted two approaches to overcome this problem: (1) we compared total number of vultures recorded on subsets of transects all of which were surveyed in all years within a specified period, and (2) we fitted log-linear Poisson regression models that allow for the effects of changing composition of the sample of transects.

In the Poisson regression analyses, the vulture count on each transect was treated as the dependent variable. The effects of transect and survey year on the number counted were modelled as factors. Including the effect of transect allows to some extent for changes across years in the representation of transects in the surveyed sample. Models were fitted in GLIM 4, with a Poisson error term and a logarithmic link function. The regression coefficients representing the year effects are the logarithms of the abundance of birds in a given survey year as a proportion of the abundance during the first survey year. Hence, the analyses yield an index of population density, which is relative to that to the first year of the series. In some analyses we included all the surveys (1992-2007), but in others we only considered the surveys during the periods 2000-2007 or 2002-2007. In particular, we analysed data for 2002-2007 for *Gyps indicus* and *Gyps tenuirostris* because these two species were separately recorded only during this period. In other periods we modelled the population index for the combined counts of these two species. However, because the total numbers of *Gyps tenuirostris* are much smaller than those of *G. indicus* (<2%), the index for the two species together can be regarded as approximately representing the situation for *G. indicus* alone.

We wished to estimate the average annual rate of population change and also to determine if it was changing over time. To do this, we fitted Poisson regression models with a logarithmic link function and transect as a factor, as described earlier, but with the effect of year modelled as a continuous explanatory variable; the number of years elapsed since the first year of the series being used. We only did this for the period 2000-2007, and not 1992-2007, because the vulture population decline probably began during 1992-2000, so it would be unrealistic to expect a constant rate of decline over the whole of this period. With this approach, the regression coefficient b of count on year represents the natural logarithm of the population multiplication rate λ, which is the ratio of the population in one year to that in the previous year. Hence, λ can be obtained as $\exp(b)$. To determine whether the rate of population change accelerated or decelerated during the study period, we fitted quadratic Poisson regression models in which both the year and the square of year were included as explanatory variables. The rate of decline is considered decelerating if the regression coefficient for the square of year is positive and is considered accelerating if this coefficient is negative.

We carried out significance tests of hypotheses about population changes using F tests, with the ratio of the residual deviance of the model with the most estimated parameters to its residual degrees of freedom being used as the error mean square. Likelihood-ratio tests were not performed because vultures often occur in groups, leading to counts being overdispersed. For this reason, asymptotic standard errors of parameter estimates are likely to be unreliable, so we obtained 95% confidence intervals for estimates using a bootstrap method. We took random samples of k transects, with replacement, from the k transects available for a particular time period. We then fitted the regression model for this bootstrap sample and recorded the value of the parameter estimate of interest. This procedure was repeated 1,000 times and the central 950 of the bootstrap estimates were used to define the 95% confidence interval. Further details of log-linear Poisson regression modeling of vulture counts are given by Green *et al.* (2004) and Green *et al.* (2007).

Crude estimates of vulture population size in 2007

We calculated rough estimates of vulture population size in northern, western, central and north-eastern India by assuming that the transect routes covered a random sample of this region. In fact, we think that this assumption is incorrect because many routes are located in or near protected areas, but we have ignored this problem in order to obtain crude estimates. We assumed that all vultures within the I km-wide recording strip on either side of the transect were detected. Hence, the area in square kilometres covered by a transect is approximately the same as its length in kilometres. We divided the total number of vultures counted on the transects covered in 2007 by their total length in kilometres to obtain an estimate of the number of vultures per square kilometre. We took the total size of the region of northern India within which the surveys were made as being approximately given by that of the states of India, excluding Goa, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. Multiplying this area by the vulture densities gives rough estimates of population size.

RESULTS

Long-term trend in vulture populations

Comparison of number of vultures counted on subsets of transects in which the same routes were surveyed in all years indicates very marked declines in numbers over the period 1992-2007 (Table 1). Numbers of *Gyps bengalensis* declined by 99.9% between 1992 and 2007 on those transects surveyed in every year during that period. The equivalent

Table 1: Number of vultures counted in each year on comparable sets of road transects in India

Species	Time period	Transects	1992	2000	2002	2003	2007
G. bengalensis	1992 - 2007	70	21,204	888	283	130	31
	2000 - 2007	17		213	180	7	23
	2002 - 2007	35			566	37	1
	2003 - 2007	10				41	25
G. indicus & tenuirostris	1992 - 2007	70	6,574	17	414	102	213
	2000 - 2007	17		223	201	238	12
	2002 - 2007	35			206	8	108
	2003 - 2007	10				3	9
G. indicus	2002 - 2007	135			812	346	333
	2003 - 2007	10				1	4
G. tenuirostris	2002 - 2007	135			19	2	2
	2003 - 2007	10				2	5

*Each row shows the total number of vultures of a given species recorded in a set of transects covered in all of the survey years within the specified time period

decline in the combined total of *G. indicus* and *G. tenuirostris* was 96.8%.

The population indices derived from log-linear Poisson regression models give similar results to those from the simpler approach adopted in Table 1. The population index for *Gyps bengalensis* in 2007 was 0.1% of that in 1992 and the index for *G. indicus* and *G. tenuirostris* was 2.6% of the 1992 value (Table 2). Even over the shorter period 2000-2007, the declines have been large. The index for *G. bengalensis* in 2007 was 2.7% of that in 2000 and the index for *G. indicus* and *G. tenuirostris* was 34.1% of the 2000 value. Averaged over the whole period 2000-2007, the declines have proceeded at an average rate of 43.9% per year for *G. bengalensis* and 16.1% per year for *G. indicus* and *G. tenuirostris* combined (equivalent to $\lambda = 0.5608$ and 0.8387 respectively; Table 2).

Recent trends of *Gyps tenuirostris*

By 2007, the population index for *G. tenuirostris* had fallen to 13.4% of its value in 2002, when the species was first surveyed separately. Although, the index values suggest that the entire decline occurred between 2002 and 2003, the confidence intervals for the indices for this species are large because few individuals are recorded. For this reason, we cannot be sure about the exact pattern of decline, though the overall reduction in numbers from 2002 to 2007 is statistically highly significant.

Have rates of population decline slowed recently?

Inspection of graphs of population index against year suggests that the population decline of *G. bengalensis* showed no clear tendency to speed up or slow down over the period 2000-2007. If the rate of decline had remained constant, a straight line relationship would give a good fit to the data in a plot of index against year, with index on a logarithmic scale. A straight line relationship appears to give a reasonably good fit to these data (Fig. 1). A statistical test for progressive acceleration or deceleration of the rate of decline is provided by comparing a quadratic log-linear effect of year with the log-linear model. This test indicates no significant tendency for a change in rate of decline in *G. bengalensis* ($F_{1,190} = 0.05$, $P > 0.4$). For *G. indicus* and *G. tenuirostris* combined, inspection of Fig. 2 and Table 2 suggests that the rate of decline might have slowed because the index values for 2003 and 2007 are similar. However, the statistical test for a change in rate shows no significant slowing ($F_{1,167} = 1.20$, $P > 0.2$). This is because the confidence intervals for the population indices are too wide for the apparent pattern to be reliable.

Crude estimates of vulture population size in 2007

During the 2007 survey, 80 *G. bengalensis*, 337 *G. indicus* and 7 *G. tenuirostris* were counted on transects, i.e. a density of 0.0042, 0.0178 and 0.0004 birds per sq. km respectively.

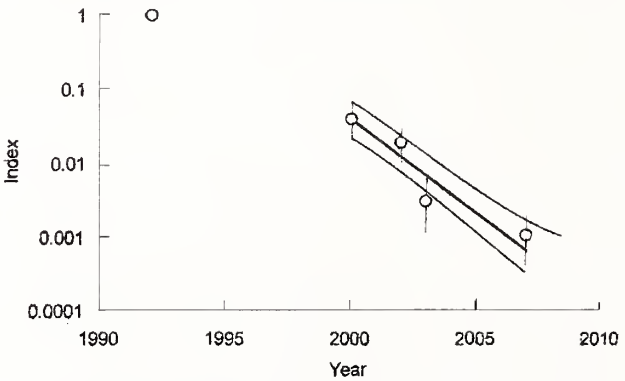

Fig. 1: Population indices and trend of Oriental White-rumped Vulture *Gyps bengalensis* from road transect counts in India

*Circles show indices of population density, relative to that in 1992, estimated by log-linear Poisson regression, together with their 95% bootstrap confidence limits (vertical lines). The thick line shows the log-linear population trend fitted to data for the period 2000 - 2007 and the thin curves show 95% bootstrap confidence limits about the fitted line.

Table 2: Population indices and trends of vultures estimated by log-linear Poisson regression from road transect counts in India.

Species	*G. bengalensis*	*G. indicus & tenuirostris*	*G. bengalensis*	*G. indicus & tenuirostris*	*G. indicus*	*G. tenuirostris*
Time period	1992 - 2007	1992 - 2007	2000 - 2007	2000 - 2007	2002 - 2007	2002 - 2007
Informative transects	119	100	78	65	33	10
Year	Population relative to that in first year of series					
2000	0.0392 (0.0196 - 0.0696)	0.0746 (0.0332 - 0.1325)				
2002	0.0192 (0.0102 - 0304)	0.0636 (0.0268 - 0.1055)	0.4923 (0.2572 - 0.9274)	0.8521 (0.3116 - 2.0417)		
2003	0.0031 (0.0010 - 0.0072)	0.0259 (0.0058 - 0.0546)	0.078 (0.0229 - 0.2080)	0.3465 (0.0657 - 1.1734)	0.4100 (01497 - 0.7106)	0.0765 (0.000 - 0.4800)
2007	0.0011 (0.0002 - 0.0028)	0.0255 (0.0092 - 0.0483)	0.0269 (0.0060 - 0.0793)	0.3413 (0.1227 - 0.8138)	0.4078 (0.1920 - 0.8182)	0.1340 (0.0000 - 0.6666)
Significance of variation in population among survey years						
F	1130.75***	269.61***	68.11***	10.13***	8.29***	5.51**
d.f.	4,378	4,329	3,189	3,166	2,62	2,16
Annual population multiplication rate λ						
			0.5608 (0.4394 - 0.6737)	0.8387 (0.6974 - 0.9429)	0.8476 (0.7108 - 1.0040)	0.7773 (0.0001 - 1.0887)
Significance of log-linear population trend						
F			157.53***	19.58***	7.15**	2.05
d.f.			1,191	1,168	1,63	1,17

*Each column shows results for a particular species and time period. Informative transects are those that were surveyed more than once and on which at least one vulture of the species concerned was recorded during the time period. Population indices are estimates of the population density as a proportion of that in the first year of the period. A 95% bootstrap confidence interval is shown for each index (in brackets). The log-linear average population trend over a given period is shown as the population multiplication rate λ, together with its 95% confidence interval (in brackets).

F tests of significance are shown with P values indicates as; *** P<0.001, ** P<0.01

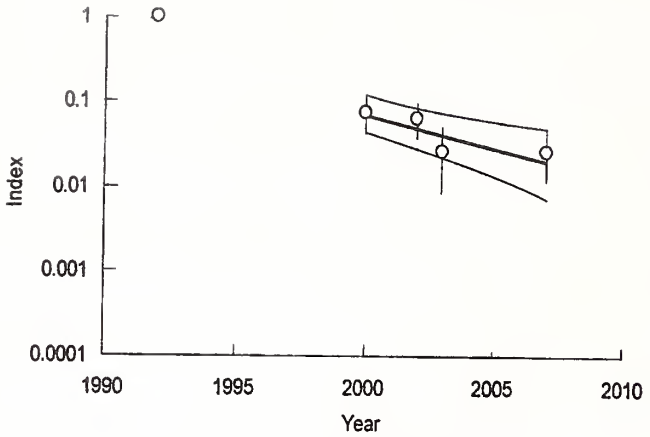

Fig. 2: Population indices and trend of Long-billed and Slender-billed Vultures combined (*Gyps indicus* and *G. tenuirostris*) from road transect counts in India.

*Circles show indices of population density, relative to that in 1992, estimated by log-linear Poisson regression, together with their 95% bootstrap confidence limits (vertical lines). The thick line shows the log-linear population trend fitted to data for the period 2000 - 2007 and the thin curves show 95% bootstrap confidence limits about the fitted line

Multiplying these densities by the approximate area of the region gives a total population of 11,000, 45,000 and 1,000 birds for the three species respectively.

DISCUSSION

The OWRV, which was the most numerous vulture species in India, is now in dire straits, with only one thousandth of the 1992 population remaining. The poisoning of vultures when they feed on the carcasses of diclofenac-treated livestock is well established and appears to be the major or the only cause of the vulture declines (Oaks *et al.* 2004; Green *et al.* 2004; Green *et al.* 2007). Simulation modeling has indicated that less than 1% of the livestock carcasses available to vultures need to contain levels of diclofenac lethal to vultures to cause the recorded rates of decline across the country (Green *et al.* 2004). A recent study carried out on the prevalence of diclofenac in the livers of livestock carcasses across India reveals that over 10% of livestock carcasses contain diclofenac. Modeling based upon diclofenac concentrations in tissues available to vultures relative to that in the liver, and the proportion of vultures killed after feeding on a carcass with a known level of contamination, indicates that there is sufficient diclofenac in livestock carcasses to have driven the vulture population declines in India (Taggart *et al.* 2007; Green *et al.* 2007).

The results of the recent surveys of vultures indicate that the three species of resident *Gyps* vultures in the Indian subcontinent continue to be in great peril. Although numbers of two species (LBV and SBV) appear to have declined less rapidly since 2003, the numbers available counted are now so small that there is no statistically robust evidence of any deceleration of the rate of decline. The population of OWRV is evidently continuing to decline rapidly. Annual rates of decline consistently over 5% are very unusual in slow-breeding and long-lived birds like vultures and place them at grave risk of extinction (Newton 1979; Sarrazin *et al.* 1994). With average decline rates (2000-2007) of 43.9% and 16.1% for OWRV and LBV/SBV respectively, these species are at severe risk of extinction in India unless survival increases dramatically over the next few years.

Although our estimates of vulture population trends are likely to be reliable, our crude estimates of the absolute numbers of vultures remaining in northern India are tentative and must be treated with caution. Their most serious defect is that they assume that the densities of vultures in the areas surveyed are representative of the whole of northern India. This is unlikely to be the case because transect routes were not selected at random, and even if they had been, they must follow roads and tracks, which may not have typical vulture densities in their vicinity. If anything, because the transects cover more protected areas than a random set would have done, our surveys may overestimate total numbers. Although thousands of vultures may remain, they are now spread very thinly across a huge area. This is a dangerous situation for such social birds, which nest and roost communally and rely on information gained from one another when searching for widely dispersed food sources. Our population estimates and measurements of decline rates suggest that all three species could be down to a few hundred birds or less across the whole country, and thus functionally extinct, in less than a decade.

If wild vultures are to persist in India, it is essential that their survival is increased both rapidly and dramatically. The ban on diclofenac production for veterinary use was an excellent first step. However, this action is insufficient on its own to save these species. It is essential that diclofenac is no longer used for the treatment of livestock, and this requires a rapid ban on the use of diclofenac in livestock. The manufacture of diclofenac for veterinary use was banned by the Drug Controller General of India in August 2006. The drug has a shelf life of 2-3 months and remaining stocks should have been out of the system by now. However, the drug continues to be available at many retail outlets and diclofenac formulated for human use filters into the veterinary sector (Nita Shah, BNHS Vulture Advocacy Programme pers. comm.). It is imperative that the drug is removed completely from use in livestock without any further delay to avoid the extinction of the three vulture species.

In addition, with small populations and the continued high mortality rates suggested by the rapid decline, it is essential that birds are brought into conservation breeding programmes as rapidly as possible, to ensure that birds are available for reintroduction once the environment is free of diclofenac. It is important to do this for all three species, but the strong evidence for continued rapid decline of OWRV makes vigorous action to safeguard this species in captivity an especially urgent priority. The rapidity of vulture decline and the uncertainty about when diclofenac contamination will be removed make the rapid expansion of the conservation breeding programme a continuing necessity. The recommendations of the Vulture Recovery Plan 2004 (ISARPW 2004) of setting up six Vulture Conservation Breeding centres in South Asia with three in India should be implemented forthwith. It is urgent to have the full complement of 25 breeding pairs of each of the three species in each of the centres to provide a viable captive population with sufficient genetic diversity and security against stochastic events. The Conservation Breeding Programme appears to be the only effective method for ensuring that further delays in removing diclofenac from the vultures' food supply do not lead to their extinction in India.

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SURVEY OF THREATENED CHEER PHEASANT *CATREUS WALLICHII* IN GARHWAL HIMALAYA[1]

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From October 2000 to December 2001, a survey on distribution of Cheer Pheasant *Catreus wallichii* was conducted in Pauri and Chamoli districts of Uttarakhand, India. Twenty-six sites in thirteen areas were identified to hold Cheer, between altitudes of 950-2,250 m in the chir pine and pine mixed forest. At all the sites, except Adwani Reserve Forest of Pauri Division, the density of Pheasant was found quite less (<2 birds/sq. km). Habitat destruction, due to fire, heavy grazing, fuel, and fodder collection was apparent at most sites. Hunting, collection of eggs and loss of brood due to fire were identified as main reasons for population decline.

Key words: Threatened, Cheer Pheasant, *Catreus wallichii*, Garhwal Himalaya, habitat degradation

INTRODUCTION

Cheer Pheasant (Order Galliformes, Family Phasianidae) is one of the pheasants of the Indian subcontinent. Its range was formerly along the Himalayan region, between the Indus and Kali-Gandaki rivers, within an altitude of 1,000-3,250 m (Garson *et al.* 1992). It prefers steep hillsides with precipitous cliffs, open ground with scattered trees (Delacour 1977; Ali and Ripley 1983; Johnsgard 1986).

In the past, over hunting and habitat destruction caused huge decline in population of this endemic species. A few decades ago, many Cheer sites were located and studied also in Nepal (Lelliot 1981, 1987; Bland 1987), Pakistan (Roberts 1970; Severinghaus *et al.* 1979) and India, namely Himachal Pradesh (Gaston *et al.* 1981, 1983; Garson *et al.* 1992; Sharma and Pandey 1989) and Kumaon region of Uttarakhand (Rasool 1984; Young *et al.* 1987). The Garhwal Himalaya had only accounts written by British naturalists living in India before independence (Jerdon 1864; Hume and Marshall 1879; Osmaston 1921). Post Independence there has been a solitary sighting of a female Cheer Pheasant at Mandal (near Gopeshwar), Chamoli district by Sathyakumar *et al.* (1992) and observations (extensive throughout the Cheer range) by Gaston (1987b). Gaston (1987b) stressed the need for surveys in Uttarakhand (formerly UP hills) and Sathyakumar *et al.* (1992) mentioned certain areas within Kedarnath Wildlife Sanctuary as possible sites.

In this paper we describe the findings of a year-long survey when many Cheer sites were accurately located for the first time in the districts of Pauri and Chamoli of Uttarakhand, India.

STUDY AREA AND METHODS

Survey for Cheer Pheasant was carried out in the districts of Pauri and Chamoli of Uttarakhand (29° 22' - 31° 07' N and 78° 07' - 80° 10' E, 750-3,750 m altitude). The vegetation of the study area can be broadly divided into sub-tropical deciduous forest, chir pine forest, temperate forest, coniferous forest, subalpine forest, alpine scrub and meadows (Champion and Seth 1968). In the local (Garhwali) dialect, in many areas of Pauri and Chamoli district, Cheer pheasant is known as 'Chair' or 'Phaklas'. Information regarding the occurrence of Cheer Pheasant was gathered from local rural fodder and fuel collectors, hunters and forest personnel. On the basis of available information, a team consisting of 2-3 observers visited the potential sites. At each site, the survey was conducted for 2-7 days, in the morning from 0500 to 1000 hrs, and in the afternoon from 1400 hrs to dusk.

Trail Walk Method (Gaston 1980) was undertaken for the presence/sightings of the Pheasant. From October 2000 to December 2001, many sites in different localities were surveyed. At each site trail walks of 4-8 km (depending on the topography and the area of the site) were covered silently and information was recorded on: (i) location of site, (ii) habitat types (iii) main vegetation (iv) number of Cheer Pheasant sighted (v) distance covered and (vi) time spent by the survey team. Area of each site surveyed for the sightings was

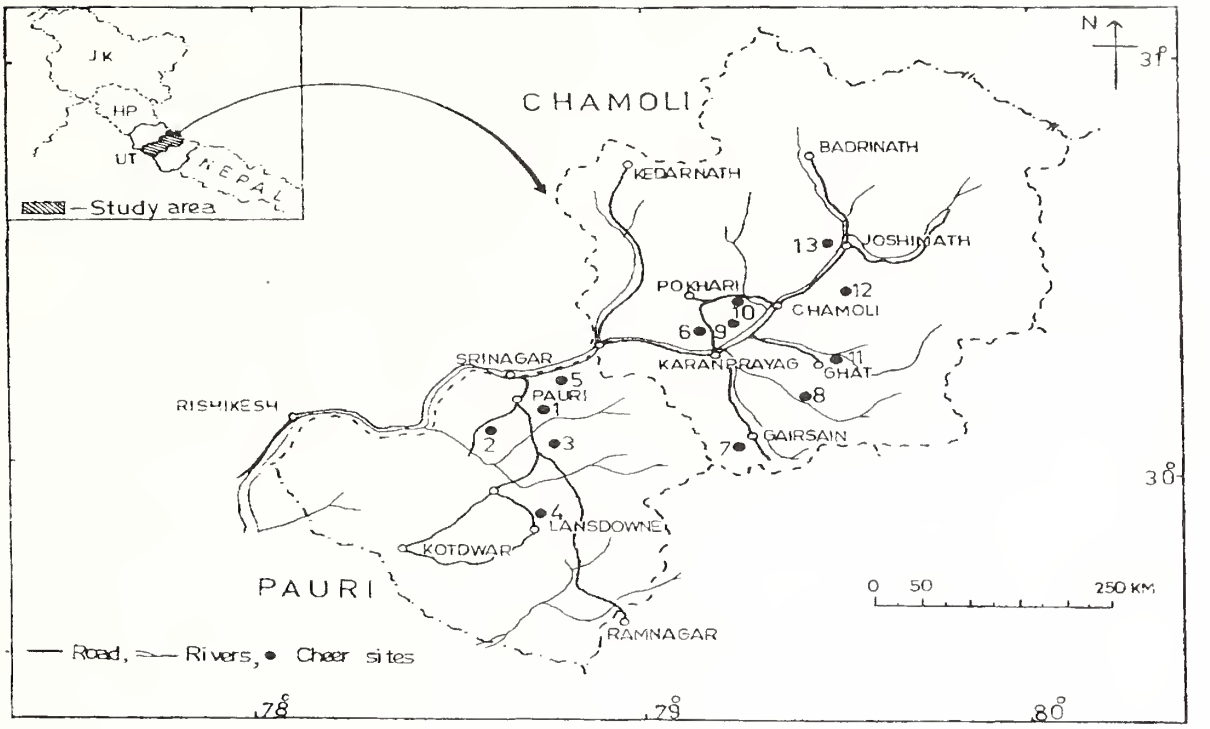

Fig. 1: Sighting areas of Cheer Pheasant in Garhwal Himalaya (1-Pauri, 2-Adwani, 3-Agrora, 4-Lansdowne, 5-Chhantikhal, 6-Karanprayag, 7-Gairsain, 8-Narayanbagar, 9-Nandprayag, 10-Trisula, 11-Ghat, 12-Peepalkoti and 13-Joshimath)

calculated from toposheets.

All the walks were repeated at least thrice to as many as 14 times to make direct sightings of maximum number of individuals at each site. The distance covered and time spent at each site was not proportional because of differing topography and difficult terrain. Chicks (being a seasonal phenomenon) were not taken as part of a population. A cumulative area of 310 sq. km of 56 sites was surveyed in 67 visits (does not include number of repeated trails on consecutive days/site). Only sites with direct sightings were taken into account.

Density is defined as maximum individuals per site divided by area of the site, and encounter rates (Birds/km and Birds/hour) as total birds sighted at each site divided by distance covered and total birds sighted at each site divided by time spent respectively.

Sampling effort (area available, distance covered, time spent and average of the three) in different habitats and altitude categories is given as proportions of the respective totals and compared with proportions of observed number of birds in each category. For the aspect category, an impression of sampling intensity is presented in terms of area covered, as the complex topography hinders the generation of required data for different aspects of the habitat surveyed. The observed pattern may have biases, as it is not corrected for availability.

RESULTS

Distribution and Status

Table 1 represents the sites holding Cheer with the associated data on altitude, slope aspect, habitat type, sightings, number of birds sighted, encounter rate (birds/km and birds/hour), density and hunting pressure. In 13 areas (Fig. 1), Cheer Pheasant was observed in 89 sightings at 26 different sites (covering an area of 124.4 sq. km). It was sighted in 5 areas of Pauri district, namely Pauri, Adwani, Agrora, Lansdowne and Chhantikhal and in 8 areas of Chamoli district, namely Karanprayag, Gairsain, Narayanbagar, Nandprayag, Trisula, Ghat, Peepalkoti and Joshimath.

The highest number of birds (12 individuals, including 3 males, 5 females and 4 subadults) were observed in Adwani Reserve Forest when the area was surveyed in the beginning of winter season. Other than adult individuals, two nests with 6 and 8 eggs were observed at Ghurdori (1,680 m) and Paukhal (1,600 m) respectively in May 2001. Out of the eight eggs (at Paukhal), 7 hatched in the following month. Chicks and subadults were also sighted at Bingarh, Gumkhal and Joshimath from June to August 2001; the highest number of chicks (8) was sighted at Joshimath.

Density of Cheer Pheasant was recorded to be < 2 birds/sq. km except at Adwani (2.18 birds/sq. km), and the lowest density of 0.34 birds/sq. km was observed at Joshimath.

Table 1: Records of Cheer Pheasant *Catreus wallichii* in Garhwal Himalaya (Based on actual sightings)

Area / site	Date of Survey	Altitude	Slope aspect	Habitat types	Total sightings	Total Individuals Sighted	Individuals sighted in single sightings		Encounter rate Birds per		Distance from Human habitat (km)	Hunting Pressure
							Max.	Min.	km	Hour		
DISTRICT PAURI												
1. Pauri												
Ghurdori	10-12 Nov. 2000	1,520-1,790 m	N-W	CPF, PMF	3	15	7(1.50)	3	0.43	1.13	0.2	+
Thapli	21-22 Dec. 2000	2,000 m	NE	CPF	1	5	5(1.25)	-	0.23	0.40	2.0	+
Chair munda	25-28 Dec. 2000	1,550-1,730 m	N, E,S	CPF	3	12	5(1.00)	3	0.28	0.72	0.0	+
2. Adwani	19-23 Nov. 2000	1,760-2,050 m	N-E	PMF	4	38	12(2.18)	7	0.50	1.76	2.0	-
3. Agrora	28-30 Dec. 2000	1,540-1,720 m	N-W	CPF	4	26	9(1.42)	3	0.67	2.11	2.5	+
4. Lansdowne												
Lansdowne	14-16 Jun. 2001	1,510-1,700 m	E	CPF	2	6	4(1.00)	2	0.16	0.48	1.0	+
Paukhal	21-24 May & 24-26 Jun. 2001	1,530-1,650 m	E-N-W	CPF	7	13+21*	2(0.55)+7*	1	0.19	0.35	0.1	+
Gumkhal	25-27 Aug. 2001	1,560-1,750 m	N-E	CPF	8	17+12*	3(0.60)+4*	1	0.37	0.89	0.0	+
Parsolikhal	28-29 Aug. 2001	1,510-1,650 m	E,NW	CPF	2	6	4(1.14)	2	0.36	0.37	0.7	+
5. Chhantikhal	15-16 Nov. 2000	1,500 m	S E	CPF	1	5	5(1.35)	-	0.23	0.94	1.5	-
DISTRICT CHAMOLI												
6. Karanprayag												
Khalsemi	13-15 Jan. 2001	1,400-1,500 m	N-E	CPF	3	13	5(0.84)	4	0.50	0.86	2.0	+
Bingar	28-30 Jun. 2001	1,450-1,730 m	N,E	CPF	9	35+18*	4(0.72)+3*	3	0.95	1.73	4.5	-
Udamanda	11-12 Jan. 2001	1,600-1,750 m	NW-E	PMF	2	8	4(0.83)	-	0.31	0.94	3.6	-
7. Gairsain	13-15 Mar. 2001	1,765-1,860 m	N,E,W	PMF	3	10	4(0.61)	2	0.25	0.68	1.5	+
8. Narayanbagar												
Kaparteer	7-8 Mar. 2001	1,550-1,730 m	N-E	PMF	3	8	4(0.66)	2	0.28	0.45	0.5	-
Khateli	9-10 Mar. 2001	1,755 m	NE	CPF	1	3	3(0.46)	-	0.10	0.35	1.0	+
9. Nandprayag												
Sonala	22-24 Jan. 2001	1,260-1,500 m	N,S,W	CPF	3	13	6(1.62)	2	0.36	1.01	1.5	-
Uttraun	16-19 Jan. 2001	1,200-1,700 m	E,N-W	CPF	6	31	7(1.84)	3	0.69	1.93	1.6	-
Thirpak	22-23 Jan. 2001	1,350-1,650 m	N,NE	CPF	3	7	3(0.93)	2	0.35	0.56	1.0	-
10. Trisula												
Ghursal	17-21 Nov. 2001	1,400-1,650 m	N,E,S	CPF	3	10	4(1.00)	2	0.17	0.52	1.5	+
Siropani	22-25 Nov. 2001	1,510-1,660 m	N-E,S	CPF	4	19	6(0.81)	4	0.29	1.13	2.5	-
Bamnath-Hapla	26-30 Nov. 2001	1,550-1,750 m	N,W,SW	CPF	3	13	5(0.83)	3	0.18	0.59	1.7	+
11. Ghat	24-25 Jan. 2001	1,530-1,650 m	N,SE	PMF	2	10	7(1.52)	3	0.47	1.25	2.0	+
12. Peepalkoti												
Birahi	21-22 Mar. 2001	950 m	S E	CPF	1	4	4(1.60)	-	0.23	0.47	0.5	+
Sallagaun	19-20 Mar. 2001	1,270-1,500 m	S-E	CPF	3	13	5(1.56)	3	0.54	1.30	0.3	-
13. Joshimath	17-18 Aug. 2001	1,800-1,950 m	N-W	CPF	5	10+17*	2(0.34)+8*	2	0.31	0.83	3.0	-
					89	350+68*	129+22*					

Total distance walked = 967.6 km; Total area covered = 124.4 sq. km; Total time spent = 387.60 hours
Values in the parentheses indicate density/sq. km; * chicks, CPF- chir pine forest; PMF- pine mixed forest

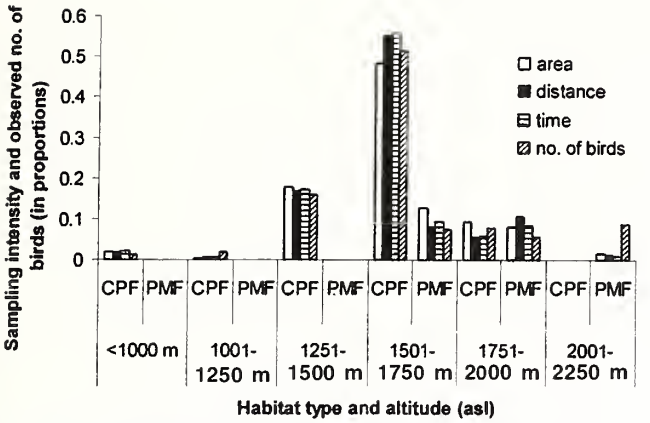

Fig. 2a: Sampling intensity and number of Cheer observed across different habitats and altitude categories

Fig. 2b: Sampling intensity and number of Cheer observed across different aspects

Encounter rate per kilometer was highest (0.95) at Bingar and lowest (0.10) at Khateli, whereas encounter rate per hour was highest (2.11) at Agrora and lowest (0.35) at Paukhal.

Habitat Preference

Cheer Pheasant was recorded between 950-2,250 m altitude and on all aspects in the chir pine and pine mixed forests comprised by *Pinus roxburghii*, *Phyllanthus embellica*, *Quercus incana*, *Rhododendron arboreum*, *Myrica nagi* (trees); *Rhus parviflora*, *Woodfordia fruticosa*, *Argemone* sp. (shrubs) and grass species like *Cymbopogon martinii*, *Heteropogon contortus*, *Anthistiria gigantea*, *Saccharum* sp.

Table 2 shows sighting of Cheer at different altitudes and habitats, where the largest number of Cheer were found between the altitude 1,501-1,750 m and in chir pine habitat. Cheer was observed to use chir pine forest (CPF) below 2,000 m and pine mixed forest (PMF) above 1,500 m. The sampling efforts (three different parameters used) in each altitude and habitat category are fairly consistent (Fig. 2a). About 75% of the surveyed areas are of chir pine forest; and the altitude range of 1,501-1,750 m comprises approximately 60%. The number of birds sighted in the altitude range and habitat category is more or less proportional to the sampling efforts, except in the PMF habitat in the 2,001-2,250 m altitude category where a significantly higher number of birds were sighted.

Table 3 illustrates that the NE aspect was used more in both the habitat types. The proportion of birds sighted in the NE aspect is significantly greater as compared to the sampling intensity (Fig. 2b). In the SW, S and SE aspects less birds were sighted. The sampling effort is lowest in SW aspect.

DISCUSSION

The present study is the first species-specific survey on Cheer Pheasant in Garhwal Himalaya. Because the survey team was very small, and as our data is based on direct sightings, the calls count method also suitable for surveying Cheer Pheasant (Gaston 1980) was not used. Cheer Pheasant is one of the most soberly feathered Indian pheasants (Singh

Table 2: Number of Cheer Pheasant *Catreus wallichii* sighted at different altitude and habitats

	Altitude in m (above msl)						
Habitat	< 1000	1001-1250	1251-1500	1501-1750	1751-2000	2001-2250	TOTAL
CPF	4	7	55	180	27	0	273
PMF	0	0	0	26	20	31	77
TOTAL	4	7	55	206	47	31	350

CPF- Chir pine forest, PMF- Pine mixed forest

Table 3: Number of Cheer pheasant *Catreus wallichii* sighted at different aspects and habitats

	Slope aspect								
Habitat	N	NE	E	SE	S	SW	W	NW	TOTAL
CPF	34	86	52	14	16	3	32	36	273
PMF	12	29	19	3	0	0	4	10	77
TOTAL	46	115	71	17	16	3	36	46	350

CPF- Chir pine forest, PMF- Pine mixed forest

and Singh 1995) and a very shy bird. It emerges from thick vegetation cover only in the morning (from their roosting tree) and also from late afternoon till dusk. Again, it exhibits perfect camouflage with fallen pine needles and dry grass cover of the habitats. Despite the difficulties in locating this pheasant, 129 individuals of Cheer Pheasant were recorded (this does not represent the actual population) at 26 sites.

129 individuals represent the cumulative total of the maximum individuals sighted at each site. The mean of total individuals sighted at each site (other than in case of single sighting) would give a lower value (as the difference between maximum and minimum individuals sighted are as high as 5); and 350 individuals recorded are the cumulative total of all the 89 sightings, where many individuals/groups were repeatedly sighted. The maximum individuals sighted at each site give a number closer to the actual population size. The higher number of birds recorded during winter season is a function of winter flocking (Kaul 1989) and might represent the actual population size. The observation of maximum individuals (more than a pair in a single sighting) during the breeding season may be the result of subadults (that cannot find a mate) of the previous year accompanying the breeding pair.

Sightings of the Cheer Pheasant at 26 different sites indicate a fair occurrence of this threatened pheasant in Garhwal, Uttarakhand. But low densities of pheasant indicate that this threatened species is not safe in Garhwal also. More than a century ago, Hume and Marshall (1879) described Cheer Pheasant as common in Garhwal and Kumaon regions. The decline in populations of Cheer from a common status in the late 19th century to its current threatened state in the Garhwal region of Himalaya is the cumulative effect of more than a century long practice of excessive hunting and habitat degradation.

Despite the complete ban under the Wildlife Protection Act (1972), hunting of pheasants during the winter months is a prevailing and increasing phenomenon. Most of the Cheer sites that have been located are under hunting pressure. For instance, at the Agrora site, 8 of the 9 birds sighted were shot, leaving a single male; and at Ghurdori and Gumkhal (August 2001), we found the remains of hunted birds.

The presence of Cheer Pheasant at 950 m at Birahi (in Chamoli district) is a significant observation, as these pheasants have never been observed at such low altitudes. Gosh (1997) had unusual sightings of a pair of Cheer Pheasant at 4,545 m in Uttarakashi, but we never encountered the bird above 2,050 m. We believe that there might be more sites, which we could not locate due to lack of surveys at such potential sites.

Cheer prefers an altitude range of 1,251-2,250 m (Table 2) in chir pine and pine mixed forest. A gradual change in habitat (pine mixed forest) selection occurs from 1,501 m onwards, which illustrate that topography is an important component of cheer habitat. The proportionately significant sighting of Cheer Pheasant in PMF at the altitude category of 2,001-2,250 m (Fig. 2a) is due to their greater availability (maximum number of Cheer – 12, was sighted in this category). The sightings of Cheer in chir pine forest (approximately 75%, in terms of area and number of sites) suggest a close relationship. Many of the habitats (Garson 1983; Young *et al.* 1987; Sharma and Pandey 1989; Garson *et al.* 1992) in other areas of Cheer range are also of Chir pine. Cheer was observed more on NE slope aspect (in both the habitats) and is more or less concentrated from NW to E through N. This gives a clear impression that Cheer prefers slopes that do not receive direct sunlight most of the day; and have comparatively softer soil, which enables it to dig out the dietary tubers and roots.

Restriction of habitat selection to chir pine and pine mixed forest makes the Pheasant vulnerable to extinction as the grass cover of *Anthistiria gigantea, Cymbopogon martinii, Heteropogon contortus, Saccharum rupifilum* is used for making brooms, cords, thatch of cattle sheds. In all surveyed Cheer habitats, it attracted the adjoining villagers and nomadic tribes, leading to frequent habitat disturbance. Fires, extensive grazing, fodder and fuel collection within the Cheer habitat is a common practice, except at few sites, e.g. Adwani, Bingar, Uttraun and Joshimath, where the habitats were intact and almost free from human interventions during the survey.

Though Cheer adapts well to the human interventions described; fires necessary for maintenance of the open grass and scrub communities (Gaston 1987a) can also result in brood losses during the nesting season. The eggs observed at Ghurdori were destroyed due to forest fire. Such losses along with predation (by *Vulpes* and *Martes*) and hunting could lead to extermination of this threatened bird from the various Cheer holding sites of this region.

Thus, the persistence of the threatened monotypic Cheer Pheasant in the Garhwal region and elsewhere could only be ensured through proper habitat management, regular monitoring of populations and particularly a strict and effective prohibition on poaching.

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POPULATION STATUS OF MONGOLIAN ARGALI *OVIS AMMON* WITH REFERENCE TO SUSTAINABLE USE MANAGEMENT[1]

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Using repeatable protocols, a survey of Argali sheep (*Ovis ammon*) in Mongolia was conducted across their range during November 2002. A country-wide population of 20,226 was estimated. Approximately 7% of Mongolia's 34,873 sq. km Argali range was surveyed. This was Mongolia's first repeatable survey for monitoring purposes. Other population estimates have been made, but the survey protocols were not given, making them unrepeatable and unusable for monitoring population trend. Population trend was established for a number of specific survey sites by comparing data collected during this survey with those done earlier in which the protocols were described. Population levels in some areas were depressed while in other areas population trend was stable or increasing. If the Mongolian Government implements a country-wide and site-specific Argali sustainable use management plan, potentially between 202-404 trophy rams could be harvested annually.

Key words: Argali, *Ovis ammon*, national population status, wild sheep, Mongolia, harvest quota

INTRODUCTION

Argali (*Ovis ammon*) wild sheep occur throughout central Asia, including Mongolia's steppe, undulating desert, and rugged mountainous landscapes (Valdez 1982; Geist 1991; Mitchell and Frisina 2007). Although their ranges are not well-defined, and some overlap may occur, Shackleton and Lovari (1997) are among those who recognize two subspecies of Argali as occurring in Mongolia: the Altai Argali (*O.a. ammon*) of western Mongolia, and the Gobi Argali (*O.a. darwini*) of the Gobi Desert in southern Mongolia. Both are listed as rare by the Mongolian Government (MNEM 1997), and are included in the United States Fish and Wildlife Service list of endangered and threatened wildlife and plants (USFWS 1997). In addition, they are listed as vulnerable and endangered by the IUCN (2000) and in Appendix II of CITES (USFWS 2001).

Mongolia, a central Asian landlocked country, encompasses about 16,56,000 sq. km of which *c.* 25% is potential Argali habitat (ASM 1990). Limited international sport hunting has been permitted since 1968. The current Mongolian law on hunting, established in 1995 and administered by the Mongolian Ministry for Nature and the Environment, regulates the commercial use of wildlife. Hunting fees are an important source of foreign currency in a badly depressed economy (MNEM 1995; Wingard and Purevdolgor 2001).

Argali populations are believed to have declined in Mongolia and throughout central Asia during the last century (Harper 1945; Mallon 1985; Heptner *et al.* 1989; Mallon *et al.* 1997; Reading *et al.* 1997). Specific and comparable country-wide population status and trend information for this species, a fundamental requirement for conservation (Wegge 1997), is lacking. Our paper provides an Argali population estimate for Mongolia. While other estimates have been published (Amgalanbaatar *et al.* 2001), ours is the first estimate determined through clearly defined field survey protocols and estimate calculation. Our estimate is repeatable for future surveys, and thus suitable for monitoring Argali population trend in Mongolia. We also discuss recent population trends at a number of specific survey sites and provide recommendations for applying our data to sustainable use of Argali.

STUDY AREA

Our study area encompassed the entire Mongolian Argali range, including the 2,435 sq. km Argali habitat in which the population surveys were conducted (Fig. 1). The Argali range in Mongolia is diverse, ranging from alpine communities in the Altai Mountains in western Mongolia, to steppe and desert communities in central and eastern Mongolia. Plant communities in Mongolia are diverse and typical of the central Asian plateau (Hilbig 1995; Gunin *et al.* 1999). Several of our survey sites were previously described in detail (Frisina and Boldbaatar 1998; Frisina and Gombosuren 1999; Frisina and Gombosuren 2000; Frisina *et al.* 2004).

Mongolia's climate is characterized by long, cold winters and short, humid summers. January is the coldest month with temperatures of -40° C or colder in contrast to >38° C during summer. Rainfall is highly variable, averaging 46 cm in the

Fig. 1: A schematic of Mongolia showing observation zones, survey site locations by number, and general area in which the Argali distribution is scattered (shaded gray). Survey sites areas follows: 1 = Buraat, 2 = Boorug Nuruu, 3 = Ahuunt, 4 = Ushgug, 5 = Ulanchulu, 6 = Darkhan, 7 = Togrug, 8 = Yurlug, 9 = Argiin Khad, 10 = Ik Nart, 11 = Choir

mountains and 10 cm in the Gobi Desert. The 1999-2000 winter was the most severe in 30 years and was preceded the previous summer by the most severe drought in 60 years (Tsend-Ayushin 2000). The climatic conditions of summer drought followed by severe winters continued through 2002 (Oyunbayar 2002; Horekens and Missiri 2002). During the 3-year period of 1999-2001, one third of Mongolia's domestic livestock (11 million) died due to these severe prolonged climatic conditions.

METHODS

Wild sheep were systematically surveyed at 11 sites within Mongolia's occupied Argali range (Fig. 1). The total area surveyed was 2,435 sq. km or *c.* 7% of Mongolia's occupied Argali range (34,873 sq. km). Occupied Argali range was determined by seeking Argali in the field during country-wide ground surveys conducted in 1993, 1997, 1998, 1999, 2001, and 2002. During these years we also interviewed local herders, hunting guides, game guards, and wildlife biologists about the distribution of Argali. Only those areas considered to be well established ranges, habitually used by Argali, were included. Many areas where Argali are only occasionally observed, or may occur only in very small numbers, were not included. Our Argali range estimate emphasizes the fall range used by wild sheep during the rutting season, the time of year they are most concentrated and readily observed for census purposes. Argali surveys done during summer or spring usually result in a relatively lower number of animals observed due to their being more widely dispersed and the adult males are in groups separate from the females.

Surveys were conducted on foot following ridgeline travel routes and from high observation points. Sheep were also observed by jeep during travel between observation points. Drop off points, base camp locations, and observation points were documented using GPS for future repetition. One observation group of 3 to 4 observers went into the field each day to observe Argali. Surveys were conducted during November 6-25, 2002, with 10 field days actually observing Argali; the remaining days were spent travelling between survey sites. Each of the 11 sites was surveyed systematically and as rapidly as conditions permitted to minimize double-counting animals. When the possibility existed that the same animals were observed more than once, only the first observation was recorded. Location and altitude at sheep sightings were recorded using a GPS.

Survey sites were chosen based on accessibility during November, their location within Mongolia's sheep range, and the availability of data collected during earlier surveys for trend comparison. We sought a representative sample from within each of the observation zones (Fig. 1). A selection of sites where hunting regularly occurs (Sites 1, 2, 3, 4, 6, 7, 8) were included in the survey (Fig. 1). Wegge (1997) emphasized the importance of surveying hunted populations.

Observed Argali densities were determined by dividing the number of animals seen by the size of the survey area. Each sheep observed was classified into one of the following categories: adult ewe, lamb, or ram. Rams were further

classified into age classes based on horn length (Geist 1966; Fedosenko *et al.* 1995) as follows: Class I (1-2 years old), Class II (3-4 years old), Class III (5-6 years old) and Class IV (>6 years old).

An estimate of argali population size was made by multiplying the average density of each zone by that zone's size (Fig. 1, Table 1). To adjust for size differences between zones, the number of argali estimated for each of the 3 zones was summed and divided by 34,873 sq. km (the total amount of occupied Argali habitat in Mongolia), which provided an adjusted density. The adjusted density was then multiplied by 34,873 sq. km for a November 2002 population estimate.

RESULTS AND DISCUSSION

Population Structure

A total of 1,085 Argali were observed during the survey, of which 1,054 were classified by sex and age. Ewes comprised 65% of Argali classified, lambs 19%, and rams 17%.

During the November 2002 survey 684 ewes and 196 lambs were counted, yielding a ratio of 29 lambs: 100 ewes, which is within the range of 10 to 63 lambs: 100 ewes reported for fall surveys by other authors (Frisina and Boldbaatar 1998; Frisina and Gombosuren 1999; Frisina *et al.* 2004). The ratio from this survey is similar to that reported for the Hangai Mountains (26.3) and higher than reported for Togrug in the south Gobi (13) during November 2000 surveys (Frisina and Onon 2000). Frisina and Onon (2000) concluded that these relatively low age ratios were likely the result of a severe winter the previous year followed by severe drought during summer 2000. Difficult weather conditions continued through 2002 with winter weather being particularly severe in the Hangai Mountains (Tsend-Ayushin 2000; Oyunbayar 2002; Horekens and Missiri 2002). Severe climatic conditions for a 3-year period immediately prior to our 2002 survey are likely the reason for the relatively low age ratios.

The 17% rams observed is slightly lower than the range of 21.5% to 37% reported by other authors for four fall surveys (Frisina and Gombosuren 1999; Frisina and Onon 2000). As with the depressed ewe: lamb ratio, the lower proportion of rams in 2002 is likely a result of winter mortality during the severe winters from 1991-2002 (Tsend-Ayushin 2000; Oyunbayar 2002; Horekens and Missiri 2002).

Of males, Class IV comprised the largest segment (45%), followed by Class III (28%), Class II (17%), and Class I (10%). Frisina and Gombosuren (2000) also reported Class IV rams as the largest male segment. However, the 45% observed during our survey is slightly lower than the range of 54.5% to 75% reported by Frisina and Gombosuren (1999), and Frisina and Onon (2000) for five fall surveys in Mongolia.

Table 1: Summary of observed Argali (*Ovis ammon*) density zonewise, November 2002

Zone	Zone Size (sq. km)	Argali Densities Avg. Density[1]	Range	Number of Survey Sites
West	25,046	0.11	0.02-0.17	3
North	2,646	0.51	0.47-0.8	3
South & East	7,181	2.24	32-5.78	5
Totals	34,873	1.19	0.02-5.78	11

[1] Number of Argali observed per sq. km

Population Size

For purposes of determining population size, Mongolia was divided into 3 zones: West Zone, North Zone, and South & East Zone (Fig. 1, Table 1). These divisions are based on differences in topography, access, and distribution of Argali that affect one's ability to sight Argali while conducting ground surveys. The West Zone includes the steep, rugged Altai Mountains, where Argali normally inhabit elevations as high as 3,600+ m. The Altai Argali habitat is a vast open landscape of interconnecting mountain ridges in which Argali are widely dispersed. Much of the Altai sheep range can only be accessed by foot and/or horseback; jeep access is very limited. The Altai Mountains have very little tree cover enabling Argali to spot potential predators from long distances. Thus, Argali survey efficiency is the most difficult in this zone, partially explaining why the lowest density (0.11 per sq. km) occurred in the Western Zone. Compared to the Western Zone, the Northern Zone is at lower elevation; the topography is less severe, and jeep access is less restricted. The Northern Zone includes the Ovorkhangai Mountains and is intermediate between the Western Zone and the South & East Zone for ability to survey Argali (0.51 per sq. km). The South & East Zone includes the vast Gobi Desert; it is the lowest in elevation, is the least severe in topography, and is highly accessible by jeep. Argali tend to concentrate within rocky areas or small mountain ranges with the desert during fall, and they tend to be more concentrated, making them more observable than within the other zones (2.24 per sq. km).

The adjusted density allowing for differences in size of the zones was 0.58 argali per sq. km. The adjusted density was used to calculate a November 2002 population estimate of 20,226 Argali for Mongolia. This is a conservative estimate; it only includes those specific areas determined to be well established Argali ranges. Areas of marginal habitat only occasionally used by Argali were excluded. The numbers of Argali counted per unit of area were assumed to be the total number inhabiting the area. Probably not all Argali within the

survey area were observed. Even aerial surveys underestimate population density (Pollock and Kendall 1987). When conducting fall surveys utilizing a helicopter, the most accurate census method, one can only expect to observe 20 to 50% of the population (Remington and Welsh 1989).

Population Trend

The country-wide population trend for Argali in Mongolia is unknown. Although a number of different population estimates (ranging from 10,000 to more than 50,000 Argali) have been made (Amgalanbaatar *et al.* 2001), the protocols have not been described, making comparison of estimates impossible. Establishing population trend for a number of specific survey sites is possible by comparing data collected during our survey with earlier surveys at sites in which the survey protocols were described. During surveys in the Western Zone (Altai Mountains – Khovd and Bayan Olgi Provinces) Frisina and Boldbaatar (1998) and Frisina and Gombosuren (2000) reported 27 and 24 Argali per day afield during July surveys in 1997 and 1999 respectively. During November 2002, 37 Argali were observed per day. Although the earlier surveys were conducted during July, they are comparable with the November 2002 survey because very little snow was present during November 2002; the weather during the survey was mild, and sheep were widely scattered at sites they typically use during July. Our findings indicate population trend at these sites within the Altai is up slightly or at least stable since 1997. During surveys in the Northern Zone (Ushgog – Ovorkhangai Province), Frisina and Gombosuren (1999) and Frisina and Yondon (2000) reported densities of 1.73 and 1 argali per sq. km during fall surveys in 1998 and 2000 respectively. During a survey of this same area during November 2002, 0.48 Argali per sq. km were observed, indicating population trend is down at Ushgig. During surveys in the South & East Zone (Ikh Nart – Dornogovi Province), Frisina and Gombosuren (1999) reported densities of 0.99 and 1.04 argali per sq. km for fall 1993 and 1998 respectively. During November 2002, 1.68 argali per sq. km were observed in this same area indicating population trend is up. At another location in the South & East zone (Togrug – Omnogobi Province), Frisina and Onon (2000) reported a density of 3 Argali per sq. km during a November survey in 2000. The survey of this same area during November 2002 yielded 1.71 Argali per sq. km, indicating population trend at Togrug may be down.

CONCLUSIONS AND RECOMMENDATIONS

Comparing this survey with previous surveys by Frisina and Boldbaatar (1998), Frisina and Gombosuren (2000), Frisina and Onon (2000), and Frisina *et al.* (2004) indicates population levels in some areas are depressed while in other areas population trend is stable or increasing. The moderate percentage of rams observed (45%) and low proportion of lambs observed (29 lambs: 100 ewes) is reflective of several years in succession of severe summer drought followed by harsh winters (Tsend-Ayushin 2000; Oyunbayar 2002; Horekens and Missiri 2002). If Argali populations were experiencing a catastrophic event, such as a disease epidemic, high mortality would be expected to occur across all age classes, not primarily with lambs and older males as experienced during this survey. The relative abundance of older rams in the population (Class III and Class IV) indicates trophy hunting has not been excessive.

As part of an overall plan for sustainable use management similar to that described by Frisina and Gombosuren (2000), and following recommendations of Harris (1993), the estimated population of 20,226 Argali in Mongolia could potentially sustain a trophy harvest of 202-404 rams annually. Harris (1993) indicated 1-2% of the total population may be safely harvested annually without negative consequences. To accurately monitor population trend and maintain sustainable harvest quotas it is important that Argali population trend be monitored through repeating the protocols established by this survey once every 3 to 5 years.

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POPULATION ESTIMATION AND DEMOGRAPHY OF THE RAJAJI NATIONAL PARK ELEPHANTS, NORTH-WEST INDIA[1]

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The Asian Elephant (*Elephas maximus*) population in Rajaji National Park, north-west India is an important part of India's heritage, but has not been intensively studied until recently. Understanding the population dynamics is important for managers if the population is to remain viable. We used marked adult male Asian Elephants in a mark re-sight method to estimate the male segment of the population and the estimated number of female and associated young using their proportions relative to the adult male segment from classification data. We collected data on inter-calving period and calf survival from adult females present in groups with radio collared females. The number of adult males in the study area was estimated to be 31 (95% CI = 23-41). We computed the relative proportions of other age-sex classes to the adult males and estimated 188 elephants (95% CI = 139-248). Ninety per cent of the adult males had tusks (tuskers) and the adult male to adult female ratio was 1:1.87. This is one of the least skewed sex ratios reported for Asian Elephants and is comparable to areas in Sri Lanka where 95% of males are tuskless. Over 90% of the adult females were accompanied by juveniles or calves <5 years old. We estimated the inter-calving period to be around 4.23 years and the calf survival over the first year was almost 100%. One calf was killed when hit by a train. The high proportion of males, low inter-calving period, and high neonate survival of the Rajaji elephant population indicates that the population is demographically healthy. However, more adult elephants died in train accidents than due to natural causes and viability of this small population could be seriously threatened if losses to train accidents continue.

Key words: Asian Elephant, inter-calving period, radio collared females, Rajaji National Park, population estimation, demography

INTRODUCTION

The Asian Elephant (*Elephas maximus*) is an endangered mammal with an estimated 35,000 to 50,000 elephants occurring in 13 countries across Asia (Kemf and Santiapillai 2000). They are long-lived animals that reproduce slowly and live in forested habitats; observations in the wild are difficult to obtain. Therefore, demographic status is uncertain for many Asian Elephant populations. Estimates of population numbers or densities are some of the basic information required to formulate proper management and conservation strategies. However, very few Asian Elephant populations have been studied (Sukumar 1991; Katugaha *et al.* 1999). Population estimates using scientific repeatable methods are rare and therefore their usefulness across the elephant range in Asia to assess viability is limited. In addition to data on demographic parameters (i.e. age-sex structure, estimates of inter-calving period, age at first conception, mortality rates) population estimates are very important to assess the status and viability of a population, yet such data is non-existent for the majority of Asian Elephant populations.

The Asian Elephant in India (*c.* 17,000-22,000) occurs in 5 major disjointed populations (Sukumar 1991; Daniel 1998). In north-west India, an estimated 800-1,000 elephants occur in Rajaji National Park (RNP), Corbett Tiger Reserve (CTR) and the adjoining forest areas. This range has been designated as Elephant Reserve 11 by the Government of India (Anon. 1993). However, the area is fragmented into 3 sub-populations (Johnsingh and Joshua 1994) and genetic continuity between them is probably maintained only by a few adult males that migrate through narrow and highly disturbed corridors.

One of the sub-populations lies between the Ganga and Yamuna rivers (Johnsingh and Joshua 1994). Elephants in this area stopped crossing the Ganga river due to the construction of a 14 km long power channel on the eastern bank (Singh 1978) and loss of a portion of the corridor area to resettlement programmes for villagers displaced by the construction of a dam upstream. In addition to the power channel, a state highway and a railroad in a corridor area prevented female movement across the Ganga river. Today potential genetic continuity between populations on either bank of the Ganga river is due to 3 or 4 bulls crossing through a narrow corridor (A.C. Williams, Unpublished data).

Information on how many elephants were present on the west bank of the Ganga river prior to and after the construction of the power canal in early 1970s is not available.

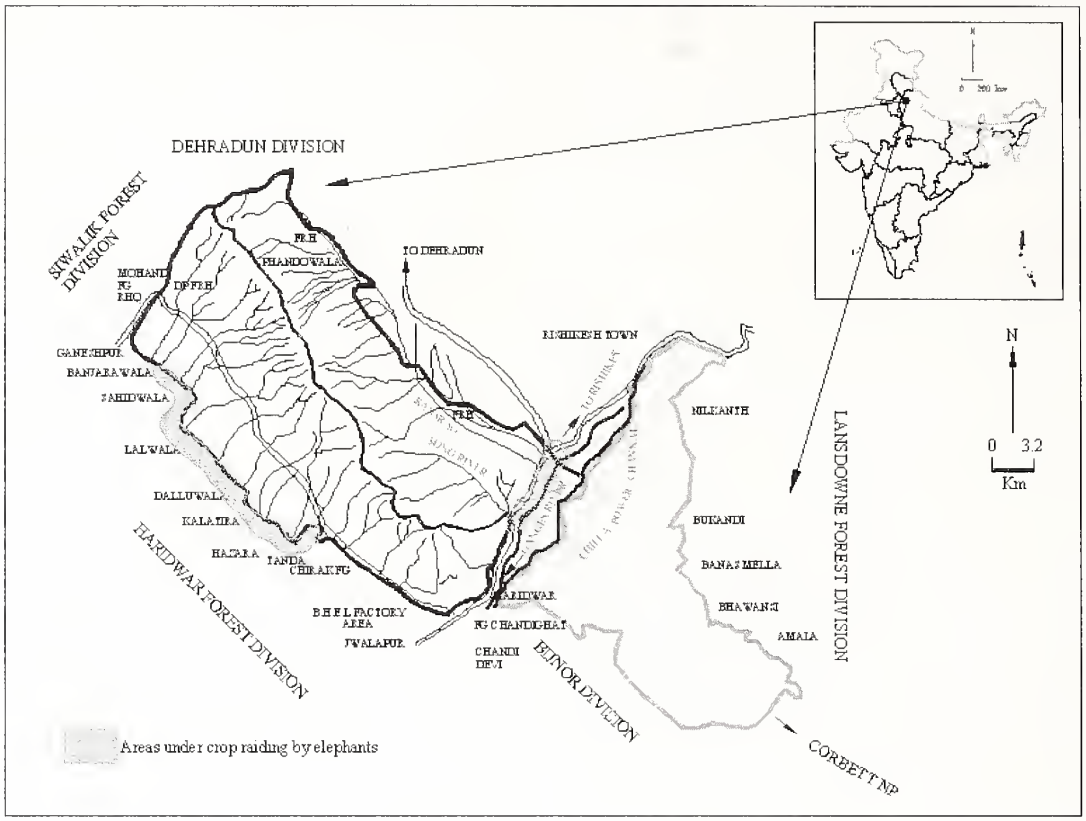

Fig. 1: Map of Rajaji National Park

Singh (1995) reported a population of 180 elephants between the Yamuna and Ganga rivers. Though ecological research on elephants in this area began in 1986, no detailed study on the elephant demography in this tract was done. As a result effective management plans could not be developed with elephant conservation as the focal point. At the same time elephants were being killed in elephant-human conflict and the effect of these losses could not be predicted, due to lack of data. Therefore, we conducted a study on elephant demography in the areas to the west of the Ganga river between 1996 and 1999. Our objectives were to investigate population parameters, like age-sex structure, inter-calving period, and calf and adult survival, and to use population models to predict the viability of this elephant population.

STUDY AREA

This study was conducted in RNP west of the Ganga river (Fig. 1) between January 1996 and June 1999. The area includes the Rajaji and Motichur sanctuaries and portions of the Shivalik and Dehradun east Forest Divisions covering an area of *c.* 500 sq. km. The distinct spine of the Shivalik ridge forms a natural boundary between Rajaji and Motichur sanctuaries. Terrain in the Rajaji Sanctuary consists of deeply dissected steep southern slopes of the Shivalik hill range, which form a series of sharp ridges, interspersed with V-shaped valleys running from north-east to south-west. The southern portion of the Sanctuary is a flat land constituting the northern fringe of the Gangetic plain (J.B. Sale, Wildlife Institute of India, unpublished report 1987). The altitude ranges from 400 to 1,000 m above sea level. Rajaji Sanctuary is divided into hills and plains. Over 1,40,000 people live along the periphery (D. Kumar, Wildlife Institute of India, unpublished report 1998). Their main source of livelihood is agriculture. The study area is bounded by intense cultivation to the north and south, and by the suburbs of the town Haridwar, on the bank of the Ganga River, to the east; to the west the Delhi-Dehradun highway separates the RNP from the Shivalik Forest Division.

Rainfall ranged from 1,300 to 1,900 mm during 1996-1999 with most of the rain falling during July to October. However, there are brief periods of rainfall throughout the year. Three distinct seasons are recognized: winter (November to March), summer (March to July) and monsoon (July to November). The major vegetation associations in this area are tropical dry deciduous dominated by *Shorea robusta*, tropical mixed forest containing *Shorea robusta*, *Mallotus philippinensis*, and *Ehretia laevis*, miscellaneous forests with *Zizyphus xylopyrus*, *Helicteres isora*, *Anoegesis latifolia*, *Dendrocalamus strictus* and plantations with *Dalbergia*

sisoo, *Acacia catechu*, *Garuga pinnata* and *Aeilanthus excelsa*. In addition to elephants, the study area provides habitat for other large mammals including Sambar (*Cervus unicolor*), Chital (*Axis axis*), Muntjac (*Muntiacus muntjak*), Nilgai (*Boselaphus tragocamelus*), Goral (*Nemorhaedus goral*), Wild Pig (*Sus scrofa*), Tiger (*Panthera tigris*), and Leopard (*Panthera pardus*). There are more than 4,000 nomadic pastoralists (i.e., Gujjars) and about 8,300 of their livestock within the study area. These Gujjar families live scattered all over the study area in small colonies. Recently, there has been a resettlement programme under which the Gujjar families are being moved away from the Park into more permanent settlements. Therefore, the biotic pressure exerted by the Gujjars is decreasing within the Park. The majority of the people in and out of RNP depend on the forests in the study area to meet their fuel wood and forage requirements.

METHODS

We immobilized four male and four female elephants with Immobilon (a mixture of Etrophine hydrochloride and Acepromazine), delivered with a dart gun, and fitted them with radio transmitters embedded on an acrylic collar (Telonics Inc., Arizona, USA). Three males and four females were radio-tracked for 1 to 2 years. We used the Mark Re-sight method (White 1996) between January 1997 and June 1998 to estimate the size of the adult male population. We identified 10 adult male elephants using distinctive naturally occurring marks (e.g. tusk shape and length, and cuts, notches and degree of ear folding) and used them with 3 adult males fitted with radio-transmitters as the marked sample. Females were difficult to identify as they did not possess tusks and it was difficult to approach them undetected close enough to be able to use other physical characteristics with any degree of success. Since no female groups encountered could be identified with certainty either as marked or unmarked, we chose to estimate only the male population size using the Mark Re-sight method. Forest blocks chosen randomly were searched for 211 days from January 15, 1997 to June 1, 1998 for 2 to 4 hours. All elephants (adult males and female groups) encountered were recorded and if marked, their identity was noted. The radio-transmitter frequencies were used only to confirm the identity of the individual male. We used the Bowden's estimator (Bowden and Kufeld 1995) to estimate the number of adult males in the population. These authors came up with a modified estimator of the Minta-Mangel model (Minta and Mangel 1989) where the variance on the re-sighting frequencies of marked animals was used for computing the confidence interval. Each animal in a population has a sighting frequency f_i. The values of f_i for marked samples are known and the sum of f_i for the unmarked animals is also known when the mark re-sighting sampling is done. Using this as an unbiased estimator and its variance were suggested (see Bowden and Kufeld 1995 for more details). The advantage of the Bowden estimator is that it allows for heterogeneity in capture probabilities and for sampling with or without replacement. The calculations were done using the Programme NOREMARK (White 1996).

We collected data on age-sex structure of the elephant population from March 1996 to June 1998. We encountered elephants when we were either searching randomly chosen forest blocks or while radio-tracking collared elephants. Whenever a female group was encountered, we classified the elephants into various age-sex categories based on relative height and morphological characteristics (McKay 1973; Kurt 1974; Daniel *et al.* 1987). Younger elephants (<15 years) were classified by comparing their height to the oldest adult female in the group (Eisenberg and Lockhart 1972). Elephants were placed in broad age groups; calves (<1 year old), juveniles (1-5 years old), subadults (5-15 years) and adults (>15 years). We included radio collared elephants in the classification data only if they were encountered randomly while searching for other elephants, not when they were located with the help of a radio signal.

We classified all adult males. However, female groups were larger and more difficult to classify than males that were usually solitary in a forested habitat like RNP. A female group was considered fully classified when all the members, except calves (<1 year old), were assigned to specific age-sex classes. Computing sex ratios using only the fully classified groups led to under-estimation of the other age-sex class proportions in the population. To correct this under-estimation, we applied the age-sex ratios of the fully classified groups to those unclassified groups in which all the elephants were counted. For those groups that were not fully counted we applied the average group size and age-sex ratios of the fully classified groups. The above correction would be wrong if unclassified groups were smaller or larger than the fully classified groups. Hence, we tested for differences in mean group sizes and distribution of group sizes between fully classified and unclassified groups. Thus, we had calculated proportions of the various age-sex classes (adult male, adult female, subadult male, subadult female, juveniles and calves) out of the total animals classified. Since we had also estimated the number of adult males in the population using mark re-sight, we estimated the numbers of the other age-sex classes by computing their proportions relative to the adult male segment and using the following simple calculation;

No. of elephants in a particular age-sex class = $(P_{iM} / P_{AS}) / N_m$

Where P_{iM} = Percentage of males in total elephants age-sex classified, P_{AS} = Percentage of elephants in a particular age-sex class, in total elephants age-sex classified, for which we are estimating numbers, N_m = No. of males estimated by the Mark Re-sight method.

To estimate inter-calving period and calf survival, we followed 19 identified females in the four collared groups and recorded the number of calves born and their survival for 3 years until May 1999. We recorded all the elephant deaths in the study area and classified them as either natural mortality or mortality related to human influence.

We used Kruskal-Wallis (K-W) One Way Analysis of Variance (ANOVA) when testing for differences in group sizes between 3 years and 3 seasons. We used Mann-Whitney (M-W) U for testing between years and seasons. We used Kolmogorov-Smirnov (K-S) two-sample test when testing for differences in the distribution of group sizes between years and seasons.

RESULTS

We recorded 101 sightings of adult males with 42 re-sightings (Table 1) of 13 marked males. All the marked animals were re-sighted during the sampling period and there was heterogeneity in sighting probabilities (Table 1). The number of adult males in the study area was estimated to be 31 (95% CI = 23-41 adult males). Males formed 16.5% of the total elephants classified (Table 2). The estimates for the other age-sex classes were computed from their relative proportions to the male segment (Table 3). There were 3 tuskless adult bulls in the population of 31 adult males indicating that >90% of the males are tuskers. We estimated a population of 188 elephants (95% CI = 139-248) in Rajaji National Park and adjoining forest areas to the west of the Ganga river (Table 3). We found the adult male to female sex ratio was 1: 1.87. This gives a crude density of 0.33 elephants/sq. km.

Between March 1996 and June 1998, we encountered males on 121 occasions and female groups on 91 occasions. Forty five percent of the female groups encountered (n = 91) were fully classified and in another 31% of the encounters, a count of all the group members was made, but they were not classified into the various age-sex categories. We found no difference (Mann-Whitney U, z = -1.0562, P = 0.29) in the mean group size or in the distribution of group sizes (K-S test, z = 0.750, P = 0.627) between fully classified groups (X = 7.20, n = 41) and unclassified groups (X = 6.64, n = 28). This indicated that size of the group did not influence whether a group was classified or not. We also did not find differences in mean group sizes (Table 1, K-W ANOVA, X^2 = 3.516, P = 0.17) or in age-class structure of the female groups (X^2 = 1.5067, P = 0.99) between years. Elephants formed smaller groups in rainy season (Table 4), but we could not detect a difference in the mean group size between the seasons (K-W ANOVA, X^2 = 3.472, P = 0.17).

We classified 300 elephants encountered in 41 female groups and 125 elephants in 121 male groups into age-sex classes. Most of the adult male sightings (>80%) were solitary. We applied the proportions estimated from the fully classified groups to the unclassified female groups to correct for under representation of the female, juvenile and subadult segment of the population (Table 2). The juvenile sex ratio was almost

Table 1: Sighting frequencies of 13 identified male elephants in Rajaji National Park, India and adjoining forest areas, 1997-1998

No. times sighted	1	2	3	4	5	6	7	8	9
Number of elephants	2	4	2	3	1	0	0	0	1

Table 2: The age-sex structure of elephants classified (N=756) in Rajaji National Park, India 1996-1999

Age-class	Percentage	
	Males	Females
Adults	16.5	30.9
Subadults	14.4	8.0
Juveniles	8.8	8.7
Calves	12.8	

Table 3: Estimate of the number of elephants in Rajaji National Park, India the various age-sex classes computed from their relative proportions to the adult male age class and associated confidence intervals (CI)

	Mean	95% lower CI	95% upper CI
Adult male	31	23	41
Adult female	58	43	77
Subadult male	27	20	36
Subadult female	15	11	19
Juvenile male	16	13	22
Juvenile female	17	12	21
Calves	24	18	31
Total	188	139	248

Table 4: The mean group size and standard error (SE) of the female groups in the three seasons in Rajaji National Park, 1996-1999

Season	N	Mean	SE
Summer	32	7.78	0.79
Rainy	20	5.50	0.69
Winter	17	7.18	1.30

equal among the juveniles that were classified by sex (n = 61). Forty one percent of the adult females were accompanied by a calf and >92% of the adult females had at least one young (<5years old) at heel. There were more subadult males than subadult females in the population (Table 2).

The 19 identified adult females in the four collared groups gave birth to 13 calves between 1996 and 1999. In the third year, one of the adult females and her calf were killed and another female could not be traced. All the females gave birth to their calves at the end of monsoon season. The number of calves born to the 19 identified females between 1996 and 1999, and surviving at the end of the first year is given in Table 5. The total adult female years monitored was 55 years and we calculated an inter-calving period of 4.23 years. All calves (n = 5) born during 1996-1997 survived for >2 years, and all but one of the calves (n = 7) born during 1997-1998 have survived for more than 1 year and 8 months.

Elephants died due to natural causes including old age and disease, and due to human related causes including train accidents, electrocution, and being killed while crop raiding. We found that twice as many elephants were killed due to human related causes as from natural causes (Table 6). Trains were responsible for more than 88% of the females and young killed (n = 9). Proportionately more adult males (3.87 males/100 males/year) died than adult females (1.72 females/100 females/year). This also held true when only adult elephants killed due to human related causes were considered; more adult males (1.94 males/100 males/year) were killed than adult females (1.23 females/100 females/year). Two female elephants and one male elephant were killed during attempted crop raiding while another adult male was almost electrocuted in the process of crop raiding.

DISCUSSION

All the males encountered were classified, as more than 95% of the sightings were of solitary males and thus close approach was possible to classify the individual. Females live in social groupings comprising of related females and their young (Douglas-Hamilton 1972) and were less tolerant of the presence of humans and hence they were difficult to approach and classify in the thick vegetation. Our results indicate that the size of the group did not influence whether a group was classified or not and also that group sizes did not differ between years or seasons. Therefore our decision to apply the age-sex structure and the average group size to unclassified groups to correct for under-representation of the female and associated age-sex classes was justified. Except for studies conducted in fairly open habitats (Katugaha 1999; de Silva *et al.* 1995), most Asian Elephant habitats are similar in structure to our study site.

The female elephants in our study area lived in social groupings of one or more adult females and their offspring as reported from Africa and Asia (Moss and Poole 1983; Moss 1988; de Silva *et al.* 1995). The females also formed similar sized groups to those reported from other studies (range 5.5 to 13.9) in Asia (Eisenberg and Lockhart 1972; McKay 1973; Kurt 1974; Daniel *et al.* 1987; de Silva *et al.* 1995). Mean group size varied between the monsoon season and the other seasons (Table 4). Mean group size can be expected to decrease when the forage is scarce and poor in quality. However, in the rainy season the quality of the forage is high. A favoured monsoon season forage species like *Dendrocalamus strictus* is distributed patchily, and smaller groups of elephants may be better able to utilize such a resource than a large group. Such a pattern has been reported for forest elephants in Africa where fruit resources are distributed patchily (White *et al.* 1993). Few adult males were seen with female groups outside of their musth period. Adult males were usually solitary as reported from other areas in Asia (Santiapillai *et al.* 1984; Daniel *et al.* 1987; Katugaha *et al.* 1999) and in Africa (Croze 1974; Poole and Moss 1981).

Adult dominated age-structures are common in Asian Elephant populations (Eisenberg and Lockhart 1972; Chandran 1990; Katugaha *et al.* 1999) given their long life span and slow reproductive rate. However, we found that there were more subadult and young elephants in the population than

Table 5: Annual birth rate of the elephant population in Rajaji National Park, India 1996-1999

	1996-97	1997-98	1998-99
Number of identified adult females	19	19	17
Number of calves born	5	7	1
Birth rate (No. of calves/adult female)	0.26	0.37	0.06

Table 6: Number of elephant deaths due to natural and human related causes in the study area, 1992-1999[a]

	No. found dead due to	
	Natural causes	Human related
Adult male	3	3
Adult female	2	5
Subadult male	-	1
Subadult female	-	2
Juvenile male	1	-
Juvenile female	-	1
Calves	-	2
Total	6	14

[a] - Deaths of adult and subadult males recorded only from 1994

adult elephants, which was similar to two other studies in southern India (Daniel *et al.* 1987; Sukumar 1991). Age structure of a population can lean towards the younger age classes due to improved fertility rates and calf survival (Caughley 1974), or due to higher mortality of adults (Jachmann 1986; Ottichilo 1986). Because there has been no report of increased mortality of adults in the study area, we think that improved fertility and calf survival is a major factor for the age structure being in favour of younger age-classes.

In contrast to other studies on elephants on mainland India (Daniel *et al.* 1987; Chandran 1990; Sukumar 1991), there were more subadult males than females in this population. In the other studies, poaching played an important role in reducing the proportion of males (subadult and adult). We did not record a single incident of poaching in the study area, but this does not explain why there is a male biased sex ratio at the subadult level. We found an almost equal sex ratio among the juveniles between 3-5 years old. The percentage of young (<5 years old) observed in this study was within the range reported for Asian Elephants in India (Daniel *et al.* 1987; Chandran 1990; Sukumar 1991).

The adult sex ratio was the least skewed among the populations studied, so far, in India. In fact the adult sex ratios were comparable to those reported from Sri Lanka (1 male: 1.9 females) where >90% of the males are tuskless (Katugaha *et al.* 1999) and hence poaching is not a problem. The north-west Indian population is the only Asian Elephant population in India where the adult sex ratio is comparable to those of the Sri Lankan populations. The proportion of adult males (16.5%) in the population is the highest when compared to other studies in mainland India (Daniel *et al.* 1987; Chandran 1990; Sukumar 1991). The reason for this is the lack of poaching in the study area during the study period.

We used the Mark-Resight method for the first time in Asia to estimate elephant numbers. We had a very high re-sighting percentage of males. However, there was a wide variation between the identified males in the number of times they were re-sighted (Table 1). We think one of the reasons for this is that some males in the study area have home ranges twice as large as other males, and thus could have been sighted by chance more often. This was the first study on Asian Elephants where numbers of males or estimates of any other age-sex class have been presented with a 95% confidence interval and therefore direct comparisons cannot be made to other studies. The estimate of 180 elephants reported by Singh (1995) was within the 95% confidence interval of 139-248 elephants estimated by us, indicating concurrence with estimates by another method. The proportion of males having tusks was similar to those of the populations studied in southern India (Daniel *et al.* 1987; Sukumar 1991). The effective population size of 80+ is higher than the minimum of 50 recommended (Franklin 1980; Frankel and Soule 1981) for the population to be safe purely from environmental and demographic stochasticity in the short term (100 years). Though this thumb rule has been criticized, Boyce's (1992) review of data showed that these are safe estimates for large mammals.

In certain populations (Chandran 1990) lack of adult males due to poaching has caused a drop in calving rates because of inability of females to find a male. We found that >95% of the adult females in our study had one young <5 years old at heel, indicating that most females do not have problems finding mates. There is a birth peak in most of the populations studied (Ishwaran 1981; Sukumar 1991; Katugaha 1993) even though newborn calves are seen throughout the year. We found that females gave birth mainly after the peak monsoon season. During the entire study period only one newborn calf was observed outside September-October. Cows need extra nutrition to support lactation (Barnes 1983; de Silva *et al.* 1995) and they also need to be in the best body condition. There is abundance of high quality food, especially new flush grass, immediately after peak monsoon season and this also coincides with the peak calving period. In the first two years of the study elephant births were high (Table 5). We calculated an inter-calving period of 4.23 years, which was similar to the inter-calving period calculated from two other studies in India (Daniel *et al.* 1987; Sukumar 1991). However, if 90% of the remaining six identified females give birth in the following year (1998-99), the inter-calving period would be around 4 years, the lowest recorded for Asian Elephants. We believe this is possible because the inter-calving period recorded from the birth of one calf to another for an identified female tracked in an area adjacent to our study site was 3.1 years (J. Joshua, Wildlife Institute of India, Unpublished Report 1993). This was the shortest recorded for elephants (Asian and African) (Laws *et al.* 1975; Smuts 1977; Jachmann 1986) indicating that elephants in RNP are experiencing a phase of high fecundity.

Earlier there were only estimates of calf survival and mortality was assumed to be around 10-25% (Daniel *et al.* 1987; Sukumar 1991). Ours was the first study which followed 12 identified female-calf units for over a year to estimate calf survival and we found that it was >90%. The only calf which died was involved in a collision with a train, which is not natural mortality. In the future the age-structure is going to be dominated by younger age classes. However, the age-ratios need to be interpreted cautiously (Caughley 1974; McCullough 1994) as the study population is undergoing an increased rate of mortality of adult females due to human induced causes.

More elephants died due to human induced causes than natural mortality. The chance of an adult male dying was higher than that of adult females, even when only deaths due to human induced causes were considered. In recent years, there have been losses of whole family groups or part of groups in train accidents. Sometimes the matriarch gets killed in these accidents. The matriarchs play an important role in elephant society and are repositories of traditional knowledge, knowing where to go during times of drought (which may occur once in 20-25 years) in search of food and water (Moss 1988). The younger females may not have this knowledge, as they might not have experienced a drought since they were born, and the effects of such losses are yet to be quantified.

Barnes and Kapela (1991) showed that the Ruaha elephant population had very poor recruitment when the adults were being poached at a high rate, illustrating that loss of adult females had an impact on every aspect of the population biology. Simulations have shown elephant populations to decline even with adult mortality rates as low as 1.5-5% if the fertility rates went down (Hanks and McIntosh 1973). Females may stop conceiving if a large number of females were to be killed every year, as happened in Ruaha (Barnes and Kapela 1991). Even if accidents were stopped, habitat degradation, which is a major problem, might affect the population parameters, thus increasing the probability of extinction (Armbuster and Russell 1993). The high proportion of males in the population, low inter-calving period and high neonate survival of the population in RNP point to a demographically healthy population. The age-structure and population parameters compare very favourably with African elephant populations known to be increasing (Douglas-Hamilton 1972; Smuts 1977). However, it would only take the death of a few more adult females/year to seriously threaten the population viability, as it is a small population. We must take urgent steps to minimize the loss of adult females to accidents and stop habitat degradation in order to keep this small elephant population viable.

CONCLUSION

The Rajaji elephant population is demographically healthy from the population characteristics (sex ratios, age-structure, inter-calving period and calf survival). However, the occasional crossing of a few elephant bulls between Motichur and Chilla across Ganga river needs to be maintained to ensure the chance of genetic flow between the otherwise fragmented populations. This will be crucial to ensure that effective population size above the critical minimum is maintained. However, too many elephants are being lost to train accidents in the study area. An analysis of future population trends, using mathematical models, indicates that a slight rise in the number of females getting killed would significantly increase the chances of this population going extinct in 100-200 years (A.C. Williams, unpubl. data). Poaching was not a problem in the study area, but a few cases were seen suddenly in 2001, and this is a cause for worry as it exposed the inadequacy of protection resources. It is urgent for the Government to take steps to reduce elephant deaths due to train accidents and poaching to ensure that this small population survives.

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SMALL CARNIVORES OF KARNATAKA: DISTRIBUTION AND SIGHT RECORDS[1]

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During a study from November 2001 to July 2004 on ecology and status of wild mammals in Karnataka, we sighted 143 animals belonging to 11 species of small carnivores of about 17 species that are expected to occur in the state of Karnataka. The sighted species included Leopard Cat, Rustyspotted Cat, Jungle Cat, Small Indian Civet, Asian Palm Civet, Brown Palm Civet, Common Mongoose, Ruddy Mongoose, Stripe-necked Mongoose and unidentified species of Otters. Malabar Civet, Fishing Cat, Brown Mongoose, Nilgiri Marten, and Ratel were not sighted during this study. The Western Ghats alone account for thirteen species of small carnivores of which six are endemic. The sighting of Rustyspotted Cat is the first report from Karnataka. Habitat loss and hunting are the major threats for the small carnivore survival in nature. The Small Indian Civet is exploited for commercial purpose. Hunting technique varies from guns to specially devised traps, and hunting of all the small carnivore species is common in the State.

Key words: Felidae, Viverridae, Herpestidae, Mustelidae, Karnataka, threats

INTRODUCTION

Mammals of the families Felidae, Viverridae, Herpestidae, Mustelidae and Procyonidae are generally called small carnivores. This category excludes Family Canidae. About 37 species of small carnivores are reported from India. They belong to the families Felidae (cats), Viverridae (civets, linsangs and binturong), Herpestidae (mongooses), Procyonidae (Red Panda) and Mustelidae (otters, martens, weasels, and badgers). Karnataka state may have 16 to17 species of small carnivores, being a highly diverse group of mammals.

Small carnivores occupy a variety of habitats ranging from dry plains, thick evergreen forests to coastal plains. However, in Karnataka most species are restricted to the forests of the Western Ghats. They play an important role as pest controllers, prey base for many animals, seed dispersers and pollinators. Some of them are also known to kill domestic chickens, and hence they are considered pests. Most species have similar food habits, feeding mostly on invertebrates, amphibians, reptiles, birds and small mammals. Although they are called carnivores, some of them also feed on fruits and seeds. Many of them are nocturnal in habit, solitary in nature, small in body size and occupy habitats with thick vegetation. Such cryptic nature of these animals made it difficult to study them, and as a result, we know little about them.

There are no detailed studies from Karnataka on any aspect of small carnivores. This is true also for other regions of India, as well as other parts of the world. However, few studies have been initiated in recent years to document the ecological aspects of these species in peninsular India (Mukherjee 1989; Mudappa 2001; Rajamani *et al.* 2003; Mukherjee *et al.* 2004). Other than these studies, most of the information on these animals comes from anecdotes or sight records, which no doubt, have significantly contributed in understanding the distribution and comparative status of these species. We have attempted to gather basic information on the distribution of small carnivores through direct sightings, and from secondary sources in Karnataka. Each species being elusive requires a long-term investigation, even to learn its distribution and basic biology. What is presented in this paper, therefore, is an updated review based on previous information, and data from the present study.

STUDY SITE

Karnataka State is located between 11° 31'-18° 45' N and 74° 12'-78° 40' E with a total area of 1,91,791 sq. km. The State receives rainfall between 450 and 7,500 mm annually, with a mean rainfall of 1,975 mm. Karnataka has been divided into four biogeographical zones, these include Coastal Karnataka with mangrove forests, Hill Region (the Western Ghats) with rainforests and moist deciduous forests, Southern Plateau and Northern Plains with deciduous forests, scrub forests and open grasslands (Prasad *et al.* 1978; Karanth 1986).

METHODS

The present study was carried out from November 2001 to December 2006 as a part of a larger study on mammals in

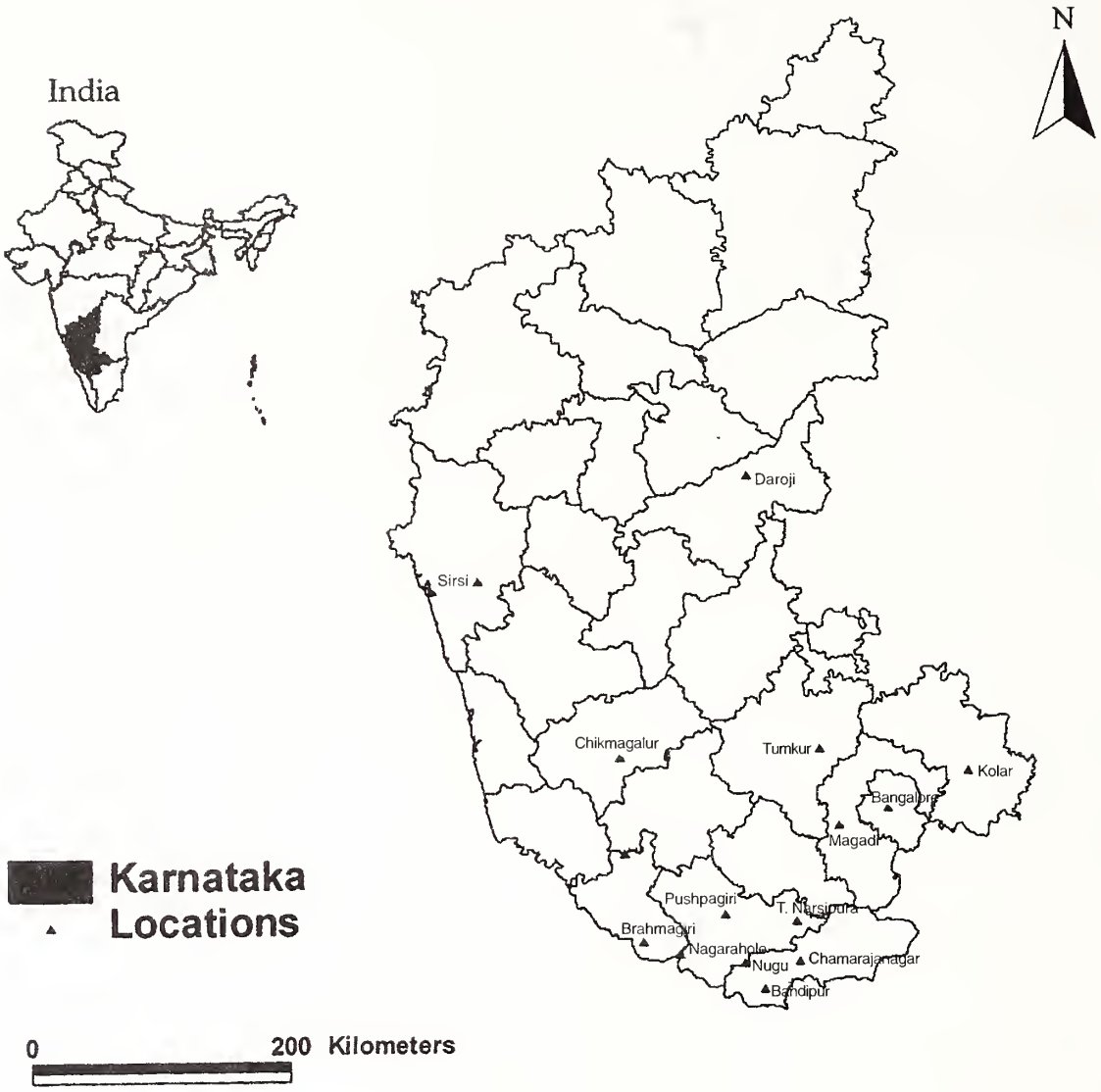

Fig. 1: Map of Karnataka with some localities mentioned in the text

Karnataka. During this period, we travelled *c.* 30,000 km across different talukas* of all districts** of the State. During these visits, we gathered secondary information on occurrence of species in the past, present status of the species, hunting practices in the region, man-animal conflict and pressure on wildlife by talking to the locals (especially elders), hunters, shepherds and forest personnel.

Apart from this, we also conducted a vehicular road survey of 9,853 km in different forests. On the basis of the information from secondary data, literature, forest types and forest status, we selected a few sites for intensive study. In those selected sites, we made 'Recky Walks' (Walsh and White 1999) of a total of 1,808 km during day and 1,096 km during night. The day survey was made from 0600 hrs, covering about 5 km/day at 0.8 km/hr, on both pre-existing trails and new routes. A pedometer recorded the distance walked. The routes were laid through different forest types. The direct evidence of traps and snares, animal remains left by hunters, hunting camps and presence of hunters was recorded in order to assess the biotic pressures. The night survey was done on foot and in vehicles; we walked after 2000 hrs on pre-existing trails at the speed of 0.5 km/hr, flashing light on both sides of the trail. During the vehicular survey, a researcher sat atop a jeep moving at a speed of 5 to 10 km/hr and flashed light connected to the jeep battery. Whenever an animal was spotted and its identity was doubtful, it was approached as close as possible and a 1millionCP spotlight

* A *taluka* is a revenue jurisdictional unit of about 1000 sq. km.
** A *District* is a revenue jurisdictional unit of eight to twelve talukas.

was flashed. The details on the methods adopted for data collection on hunting practices are published elsewhere (Kumara and Singh 2004).

OBSERVATIONS

Table 1 presents a summary of the information on different species regarding their IUCN status (IUCN 2003), place in various Schedules of the Indian Wildlife (Protection) Act 1972, and the type of habitat inhabited by each species. We sighted a total of 143 animals of 11 species of small carnivores in the State during the present study (Table 2).

Family Felidae

Four species of small cats – Leopard Cat (*Prionailurus bengalensis*), Rustyspotted Cat (*P. rubiginosus*), Fishing Cat (*P. viverrinus*) and Jungle Cat (*Felis chaus*) – are expected to be present in the State. The Jungle Cat is the largest, while the Rustyspotted Cat is the smallest weighing 1-2 kg (Nowell and Jackson 1996). Jungle Cat has the widest distribution globally; Fishing and Leopard cats are distributed in several Southeast Asian countries, and Rustyspotted Cat is endemic to India and Sri Lanka (Nowell and Jackson 1996).

Leopard Cat: It has been reported to occur in some reserves of Karnataka (Karanth 1986), on the basis of secondary information. A total of eleven animals were sighted during this survey: five in Sharavathi Valley Wildlife Sanctuary, two each in Bandipur National Park and Talakavari Wildlife Sanctuary, and one each in Pushpagiri Wildlife Sanctuary and in a coffee estate in Virajpet adjacent to Brahmagiri Wildlife Sanctuary in Kodagu district (Fig. 1). The animal in the coffee estate was seen among bushes, along the fence of the estate. The local information revealed that Leopard Cats are quite common in Kodagu. The species is found to occur along the forests of the Western Ghats, and also adjacent deciduous forests. No information was available from the drier plains of the State. It has also been sighted on the fringes of a coffee estate adjacent to Bhadra Wildlife Sanctuary in Chikmagalur (Narsimha, pers. comm.). Leopard Cats have often been recorded in evergreen forests and adjacent croplands in Kalakkad-Mundanthurai Tiger Reserve (Mudappa 2002) and Indira Gandhi Wildlife Sanctuary (Kumar *et al.* 2002).

Rustyspotted Cat: We sighted three Rustyspotted Cats during the study period. One animal was sighted in Nugu, one in Bandipur National Park and one in Sira of Tumkur. The sighting in Nugu was at 1950 hrs, on a fig tree (*Ficus bengalensis*) at a height of about 5 m, the tree was 16 m tall. Because of the disturbance caused by our presence, the animal moved to an open area and became completely visible to us. We watched the animal for about 20 minutes. The white ventral portions were dotted with black spots. The dorsal gray hair with a reddish tinge had rusty spots, and the tail was without

Table 1: Official status and distribution of small carnivores of Karnataka

Family	Common name	Scientific name	IWPA Status	IUCN Red List status	Distribution
Felidae	Leopard cat	*Prionailurus bengalensis*	I		1,2,3?
Felidae	Rustyspotted cat	*Prionailurus rubiginosus*	I	VU	2?,3,4
Felidae	Fishing cat	*Prionailurus viverrinus*	I	VU	1?
Felidae	Jungle cat	*Felis chaus*	II		1,2,3,4
Viverridae	Malabar civet	*Viverria civettina*	I	CR	1?
Viverridae	Small Indian civet	*Viverricula indica*	II		1,2,3,4
Viverridae	Asian palm civet	*Paradoxurus hermaphroditus*	II		1,2,3,4
Viverridae	Brown palm civet	*Paradoxurus jerdoni*	II	VU	1
Herpestidae	Common mongoose	*Herpestes edwardsii*	IV		1,2,3,4
Herpestidae	Ruddy mongoose	*Herpestes smithii*	IV		2,3,4
Herpestidae	Stripe-necked mongoose	*Herpestes vitticollis*	IV		1,2,3
Herpestidae	Brown mongoose	*Herpestes fuscus*	IV	DD	1
Mustelidae	Eurasian otter	*Lutra lutra*	II		?
Mustelidae	Smooth-coated otter	*Lutrogale perspicillata*	II		?
Mustelidae	Small-clawed otter	*Aonyx cinereus*	I		?
Mustelidae	Nilgiri marten	*Martes gwatkinsii*	II	VU	1?
Mustelidae	Ratel	*Mellivora capensis*	I		2?,3, 4?

IWPA-Indian Wildlife (Protection) Act 1972.
IUCN-The World Conservation Union.
I,II and IV-Schedules In Indian Wildlife (Protection) Act.
VU-Vulnerable; CR-Critically Endangered; DD-Data Deficient
1-Wet forests of the Western Ghats (evergreen forest), 2-Dry forests adjacent to Western Ghats (deciduous forests),
3-Dry forests of southern plateau (deciduous forests, including forests of Eastern Ghats), 4-Northern plains
?-No reliable information

any spots or markings. We identified the animal as Rustyspotted Cat and later confirmed it by referring to Prater (1971). The animal was in a tree at the border between the Sanctuary and cultivated croplands. The closest village was about half a kilometer away. The other sighting at three and a half kilometers from Sira town was at a roadside Tamarind tree (*Tamarindus indica*) at 2330 hrs. It was at a height of about 2 m, the tree was about 6 m tall. The cat remained on the tree for about 5 min. It moved to another branch, due to disturbance, but remained there in spite of our presence. The sighting locality was close to human habitation, which is adjacent to a reserve forest. The general forest type of the region is dry scrub or dry deciduous. The interesting observation was that both the sightings were on trees, and the animals were not unduly disturbed. Rustyspotted cats are known to be arboreal and nocturnal (Nowell and Jackson 1996). The sighting in Bandipur National Park was on October 11, 2006 in Bandipur Range at 2130 hrs. The animal was on ground adjacent to bushes and remained there without any movement for about 12 min. It later moved inside the bushes.

The only published report on the occurrence of Rustyspotted Cat from southern India was from Andhra Pradesh (Rao *et al.* 1999) and drier forests of Kalakkad-Mundanthurai Tiger Reserve in Tamil Nadu (Mudappa 2002). Mudappa (pers. comm.) also reported its occurrence in Indira Gandhi Wildlife Sanctuary in Tamil Nadu. Karanth (1986) considers southern plateau as a nominal distribution range of this species, but no sighting or occurrence was reported in Bhadra Wildlife Sanctuary (Karanth 1982) and Bandipur (Karanth 1988). However, the recovery of one skin from the outskirts of Bangalore city was reported. Although there are no published sight records, there are few sightings from different parts of the State, e.g. the animal was sighted in Chikmagalur (Fig. 1), Kadur and Ranebennur (D.V. Girish, pers. comm.). Our report confirms its occurrence in Karnataka.

Fishing Cat: Prater (1971) reported the Fishing Cat to occur in some coastal districts of Karnataka; no recent sightings are reported from any part of the State. Along the coastal districts, the local information revealed no sightings of this species in recent years. Even in the past, the information on the species was vague. Karanth (1986) also reported no reliable information on this species in recent years from the West coast, and he suspects that the species could be locally extinct.

Jungle Cat: This is one of the most common species of small carnivores found to occur in all the districts of the State. They occur at all altitudes ranging from the coast to high altitudes of the Western Ghats. Further, they occupy most of the habitat types varying from coastal habitat, evergreen forests of the Western Ghats to dry plains. We saw scats and pugmarks of the species in the forests in the Western Ghats, one animal was sighted at Pushpagiri Wildlife Sanctuary, twice in Nugu, five times in Tumkur, once in Kolar and once in the Chamundi hill near Mysore (Fig. 1). All sighted animals were adults. Most sightings were close to some water bodies or in the croplands.

Viverridae

Four species of civets: Malabar Civet (*Viverria civettina*), Small Indian Civet (*Viverricula indica*), Asian Palm Civet (*Paradoxurus hermaphroditus*), and Brown Palm Civet (*P. jerdoni*) are expected to occur in Karnataka. The Malabar and Brown Palm civets are endemic to the Western Ghats, whereas the Small Indian and Asian Palm civets have wide distribution in South-east Asia.

Malabar Civet: The species is extremely rare, and is listed under Schedule I of the Indian Wildlife (Protection) Act. We did not sight the animal during the present study. The only information available on this species is 'a possible sighting in Kudremukh' (Karanth 1986). A later survey (Rai and Kumar 1993) also revealed a 'possibility of occurrence' along certain regions of the Western Ghats in Karnataka. The only evidence of its occurrence in its distributional range is the recovery of two skins from Nilambur in northern Kerala (Ashraf *et al.* 1993). According to Rai and Kumar (1993), Malabar Civets probably occur widely in Karnataka due to the presence of extensive lowland forests along the Western Ghats.

Small Indian Civet: The Small Indian Civet is widely distributed in Karnataka, and is found to occur in various habitat types. The habitats range from coastal plains to wet evergreen forests, deciduous forests, dry scrub and rock dominated dry forests. They occur at altitudes ranging from <50 m to 1,400 m above msl. We sighted 13 animals during this study, one animal each in Brahmagiri-Makut, Bandipur National Park and Nugu, five animals in Nagarahole, three animals in Tumkur district and one each in Kolar and Chikmagalur districts. The sightings varied from crop fields in the drier plains to evergreen forests of the Western Ghats. All sightings were during night.

Asian Palm Civet: Asian Palm Civet is found in most of the forest types including coast to dry plains, except in high altitude evergreen forests. The species is capable of adapting to various habitats, forest types, including living in townships. They have often been observed to breed in house roofs in coastal plains of Udupi, and also in dry plains, such as Bidar district with little forest. However, they are very rare or absent in areas completely bare and without any vegetation. We sighted 32 animals during the present study. The sightings included two animals each in Brahmagiri-Makut and Sirsi-

Honnavara, nine animals in Nagarahole (Fig. 1), five animals in Chamundi hill, three animals each in Sharavathi Valley Wildlife Sanctuary and Bandipur National Park, and four animals each in Talakaveri Wildlife Sanctuary and Pushpagiri Wildlife Sanctuary. Although 15 animals were sighted in the Western Ghats region, the sightings were mostly from moist deciduous or deciduous forests.

Brown Palm Civet: Brown Palm Civets are considered to be restricted to the evergreen forests and the adjacent forests of the Western Ghats, ranging from Brahmagiri in the south to Khanapur (Belgaum district) in the north. During the present study, we found them to be absent in deciduous forests adjacent to the Western Ghats. We have not sighted the species in Nagarahole in spite of every effort. We sighted a total of 18 animals in different regions of the Western Ghats. The sightings were more in Brahmagiri-Makut and Sharavathi Valley Wildlife Sanctuary (5 animals each) followed by Sirsi-Honnavara (4 animals) and Pushpagiri-Bisale and Pushpagiri Wildlife Sanctuary (2 animals each). Rajamani *et al.* (2003) reported high encounter rate of Brown Palm Civet in other parts of the Western Ghats in Karnataka. All sightings were during nights in evergreen forests and on trees. Earlier, it was thought that the species is rare in its entire distributional range, but recent studies show that it is quite common (Mudappa 2001), and is distributed from the southern extremity of the Western Ghats in Kalakkad-Mundanthurai Tiger Reserve to Dhud Sagar in Goa in the north (Rajamani *et al.* 2003). Rajamani *et al.* (2003), based on the specimen collected by R.C. Morris in Bombay Natural History Society Museum, considered the species to occur in Biligirirangan Hills near Mysore. However, it needs further investigation since no information was found on occurrence of this species in these hills during the present study.

Family Herpestidae

Four species of Herpestidae: Common Mongoose (*Herpestes edwardsii*), Ruddy Mongoose (*H. smithii*), Stripe-necked mongoose (*H. vitticollis*), and Brown Mongoose (*H. fuscus*) are expected to occur in Karnataka. The Common Grey mongoose has a wide range in India, Persia, Mesopotamia and southwards to Sri Lanka. The Stripe-necked and Brown mongoose are restricted to the Western Ghats and the Ruddy Mongoose is restricted to central and southern India (Prater 1971).

Common Mongoose: It is one of the common animals in the open countryside in India. In Karnataka, they are found in coastal plains, disturbed evergreen forests and dry plains. However, they may be rare or even absent in high altitude rain forests. We sighted two animals each in Tumkur, Nugu and Chikmagalur, three in Bandipur National Park, four in Mysore, and one in Bangalore (Fig. 1). In spite of the vigorous efforts in evergreen forests of the Western Ghats and deciduous forests of Nagarahole, no animal was sighted. All the sightings were during the day. We sighted young ones during September-October (2003).

Ruddy Mongoose: Ruddy Mongoose is absent in coastal and evergreen forests of the Western Ghats. They occur in dry forests and forests with rocky outcrops, and are absent in completely barren areas. We sighted five animals in Nagarahole, three in Bandipur National Park, one each in Hasanur forests in Chamarajnagar and Savandurga forests in Magadi of Bangalore district, and six in Daroji Bear Sanctuary (Fig. 1) in Bellary district. All sightings were either in the morning or in the evening, in dry forests or rocky areas. Animals were seen in pairs thrice. Animals are also sighted frequently in Bhadra (Narasimha, pers. comm.) and Bandipur (Karanth 1986, 1988).

Table 2: Sightings of small carnivore species only during night walk

Area	km walked	Leopard Cat	Rustyspotted Cat	Jungle Cat	Small Indian Civet	Asian Palm Civet	Brown Palm Civet	Nilgiri Marten
Brahmagiri-Makut	51	1	-	-	1	2	5	-
Pushpagiri-Bisale	123	-	-	-	-	-	2	-
Sirsi-Honnavara	119	-	-	-	-	2	4	-
Nagarahole	121	-	-	-	5	9	-	-
Nugu	60	-	1	2	1	-	-	-
Tumkur	105	-	1	5	3	-	-	-
Bangalore	102	-	-	-	-	-	-	-
Kolar	92	-	-	1	1	-	-	-
Chamundi Hill in Mysore	22	-	-	1	-	5	-	-
Sharavathi Valley WS	69	5	-	-	-	3	5	-
Pushpagiri WS	32	1	-	1	-	4	2	-
Talakaveri WS	80	2	-	-	-	4	-	1
Bandipur NP	120	2	1	-	1	3	-	-

Stripe-necked Mongoose: Stripe-necked Mongoose occurs in evergreen forests of the Western Ghats and adjacent dry deciduous forests in the State. We sighted 12 animals in Nagarahole, five in Bandipur, and four in Talakaveri Wildlife Sanctuary. They have been frequently sighted in Bhadra (Narasimha, pers. comm.). All sightings were during the daytime, especially in the early mornings and late evenings. Pairs were sighted four times. It appears that Stripe-necked Mongoose is more common than other mongoose species in deciduous forests like Nagarahole and Bhadra.

Brown Mongoose: It is a rare species sighted very infrequently. There are no sighting records from Karnataka in recent years, and they were not sighted during the present study too. Karanth (1986) reported the occurrence of the species in the Western Ghats and in the southern plateau, especially in Nagarahole, but we doubt its occurrence in Nagarahole. They are relatively rare even in other parts of its distribution in India (Mudappa 2002).

Family Mustelidae

Of the Mustelids, Smooth-coated Otter (*Lutrogale perspicillata*), Small-clawed Otter (*Aonyx cinereus*), Eurasian Otter (*Lutra lutra*), Nilgiri Marten (*Martes gwatkinsi*) and Ratel (*Mellivora capensis*) are known to occur in the State. Among otters, the Eurasian Otter has a large distribution ranging across different continents, including Europe, North Africa and Asia, whereas the other two species are restricted to South-east Asia. The Small-clawed and Eurasian otters usually inhabit high altitude mountain streams, whereas the Smooth-coated Otter inhabits streams and lakes of plains. The distributional range of Nilgiri Marten is restricted to the Western Ghats, and the Ratel has a wide distribution from south-western Asia to Africa (Prater 1971).

Otters: During this study, we encountered otters only at two sites of Cauvery river near T. Narasipura (three animals) and at Sangama (one animal). The species could not be identified with certainty and hence the distribution could not be provided at species level. The otters occur in Bheema, Krishna, Ghataprabha, Malaprabha, Tunga, Bhadra, Hemavathi, Kapila, and Cauvery rivers that run east of the Western Ghats, and in the Western Ghats and rivers draining towards west. We noticed large number of scats along the River Cauvery and its tributaries, indicating high density of otters. The rivers draining west from the Ghats in Dakshina Kannada, Udupi and Uttara Kannada also appear to have good population of otters. The local information revealed that during the high tide and monsoons, otters are seen even at the coastline; otherwise they are seen at estuaries or just before the estuaries where the population is continuous towards fresh water. Karanth (1982) reported the Common Otter from the Bhadra Reservoir in Shimoga district.

Nilgiri Marten: Nilgiri Marten is endemic to the Western Ghats, and is reported from Nilgiris, south Coorg and Travancore (Prater 1971). During the present study, we sighted one animal in Talakaveri Wildlife Sanctuary. However, local information revealed that the Nilgiri Marten is still found along the Western Ghats. Earlier they were present in large numbers, but due to the conversion of the forests of the Western Ghats to coffee plantations and honey culture, the intensity of hunting increased. Nilgiri Martens were believed to raid Bee hives, and hence planters considered them as pests, and killed them. Even today, people have a tendency to kill martens if they see them. Marten is also hunted for domestic consumption. Although no data are available regarding its earlier status, the local information revealed that the population of Nilgiri Marten in Karnataka has gone down drastically.

Ratel: Ratel is usually found in plains and lives by making a den in the earth. Before 1960s, it was reported from some parts of Kolar district in Karnataka. However, there has been no information during the recent decades on this species. We talked with the people, described the animal, and showed its picture, but there was no positive response for the occurrence of this species from any part of the State. However, during 2003, one animal was recovered from 'Sathanur' of Kanakapura taluka of Bangalore (Rural) district. The animal was found in a shallow well, just outside the village, where cropland and shrub forest is interspersed (Doddalanahalli village). The animal was shifted to Sri Chamarajendra Zoological Garden, Mysore. It survived for only a few days. Interviews with the villagers and forest officials in the range revealed no sighting of the species in the same locality. The species is present probably in very low numbers.

Threats

Local hunting and habitat loss are the major factors affecting the status and distribution of small carnivore species. In addition, road network with busy traffic in forest areas also causes many road kills of small mammals (Kumara *et al.* 2000). Although Western Ghats, where most of the small carnivore species occur, have been recognized as one of the Hotspots of World Biodiversity (Myers *et al.* 2000), the attention paid to conserve this region is still not satisfactory. Among such biodiversity hotspots, Western Ghats also have high human density (Cincotta *et al.* 2000). Menon and Bawa (1997) reported a 40% loss in forest cover between 1920 and 1990 in the Western Ghats. Such a sharp decline of forests results in habitat alteration, degradation of the forest and an increase in number of forest fragments. Such factors certainly make an uncertain future for small carnivores.

In addition to habitat loss, local hunting has made small carnivores uncommon in their natural habitats. All small carnivore species are hunted. There are no taboos attached to hunting of such species in any community or ethnic group. The hunting or capturing techniques vary between species. Jungle Cat, Leopard Cat, Asian Palm Civet, mongoose species and Nilgiri Marten are hunted for meat throughout their distributional range in the State. Commercial hunting of these species has gone unnoticed in the State. Common mongooses are hunted for their hair, and they are also captured to keep as pets and for use in the local circus or road shows for snake-and-mongoose fights. The hunting methods vary from use of muzzle load guns to various types of traps, depending on the access to arms.

Along the west coast, especially in Dakshina Kannada, commercial captive rearing of the Small Indian Civet is common. Animals are captured from the forest and they are kept in specially designed cages. The cage could be of a circular or a rectangular shape with about 1 m each in radius and height. It has a smooth pole at the centre, and the rest of it is fixed with wire mesh. The animals rub their glands on the pole and deposit the secretions. Once the deposition reaches a certain amount, it is scraped. Each gram of this secretion costs around Rs. 900 to Rs. 1000 in the market, as it is used in ayurvedic medicine and for perfume manufacture. This practice has resulted in an indiscriminate capture from nature without any legal approval. If this practice continues unchecked, it can significantly affect the status of the species. Small Indian Civets are also hunted using various methods throughout Karnataka for meat. In spite of its widespread distribution and adaptability to a variety of habitats, the above factors can cause local extinction of this species.

The body weight of Brown Palm Civets varies across seasons. They are believed to hunt more during August and October, when they become fat. People who hunt this species consider its meat very relishing. Hence, the hunting pressure on this species is severe and people go on hunting expeditions during the post-monsoon period. Locals also devise special traps designed exclusively to capture brown palm civets. Brown Palm Civets usually use dead wood or exposed rocks to excrete, and use fallen wood (especially fallen wood across valleys/streams) to move. The traps are fixed on such fallen wood. On several occasions we found leftovers, such as skin and bones after the hunting expeditions. Brown Palm Civets are also recovered from the nests of Giant Squirrels. However, no commercial trade of this species was observed in Karnataka.

In some regions of the Western Ghats, especially Kodagu and Dakshina Kannada districts, people of certain communities (Erava, Kuruba, Kodava, Naika) hunt otters. The otters are caught in nets fixed in shallow waters. Trained dogs are used to catch the animal from these nets. Otters are also killed using guns, and retrieved using trained dogs.

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LENGTH-WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR OF JUVENILE GOLDEN MAHSEER *TOR PUTITORA* (HAMILTON 1822), IN THE TRIBUTARIES OF RAMGANGA RIVER, UTTARAKHAND[1]

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The length-weight relationship and condition factor of juvenile Golden Mahseer *Tor putitora* was observed from samples collected between November 2004 and May 2005, in the Khoh, Kolhu and Mandal rivers, tributaries of the Ramganga river, in Uttarakhand. Golden Mahseer found were mostly less than one year old. There was no significant difference found between rivers in respect of length-weight relationship and condition factor of Golden Mahseer. The estimated condition factor for Golden Mahseer across rivers was low (Kn = 1.10), however, the condition factor of larger fish in the samples was good.

Key words: rivers, length-weight relationship, condition factor, umbrella species

INTRODUCTION

Golden Mahseer *Tor putitora* (Hamilton 1822) belongs to the Family Cyprinidae. It has wide distribution all along the foothills of Himalaya. It also occurs in Nepal, Myanmar, Bangladesh, and Pakistan. Body size of fish is an important predictor for species diversity and density distribution (Knouft 2002; Ulrich 2004). The length-weight relationship is an important indicator for predicting gonadal development, metamorphosis, maturity, and condition of fish (Le Cren 1951). The length-weight relationship (L / W) has been widely used in fish biology with several purposes, e.g. to estimate the mean weight of the fish, based on known length (Bayer 1987), and weight as a function of length (Hile 1936). The condition factor Kn (Le Cren 1951) is a quantitative parameter for the well-being of fish and reflects recent feeding conditions. This factor varies according to influence of physiological factors fluctuating according to different stages of development. Anderson and Neumann (1996) refer to length-weight data of a population, as a basic parameter for monitoring study of fisheries, since it provides important information concerning the structure and function of populations. According to Le Cren (1951), the relative condition factor is affected by length as well as several other factors like environment, feeding and breeding.

Studies on spawning ecology (Nautiyal and Lal 1981), migratory behaviour (Nautiyal and Lal 1983) and length-weight relationship of Golden Mahseer (Nautiyal 1985a) have been carried out in the Garhwal Himalaya. Tributaries of the Ramganga river of lower Garhwal Himalayan region were identified as one of the important Mahseer areas (MacDonald 1936); however, there was no study on the ecology of the Golden Mahseer from this region. The objective here is to determine the length-weight relationship and variations in the condition factor of Golden Mahseer *Tor putitora* among different tributaries of the River Ramganga.

STUDY AREA

River Ramganga is one of the principal rivers of the Shivalik range or lower Garhwal Himalaya. Khoh, Kolhu, and Mandal are the tributaries of this river. Khoh originates from Dwarikhal in the north and drains through Shivalik ranges and is situated between 29° 45' 27"-29° 48' 22.1" N and 78° 32' 22.4"- 78° 36' 18.5" E in the southern part of the Pauri-Garhwal district of Uttarakhand state (Fig. 1). Kolhu is situated between 29° 41' 39.2"-29° 42' 46.3" N and 78° 31' 42.3"-78° 37' 41" E. Mandal is situated between 29° 35' 5"-29° 38' 9.9" N and 79° 00' 34.1"-78° 57' 9.7" E, rises in the eastern heights in Chamoli district and flows north to east of Corbett National Park, where it meets the Ramganga river.

MATERIAL AND METHODS

Survey of fish fauna in the tributaries of River Ramganga was carried out using a cast net having mesh size of 1 x 1 cm over a period of five months during December 2004 to April 2005. Sampling was carried out throughout the day. Collected fishes were placed in a bucket of water, and the total length (L) in cm, and body weight (W) to the nearest 0.1g were measured using Vernier caliper and pasola spring balance. After recording various morphometric characters, such as head length, body depth, eye diameter and total body length, the fishes were released back into the rivers.

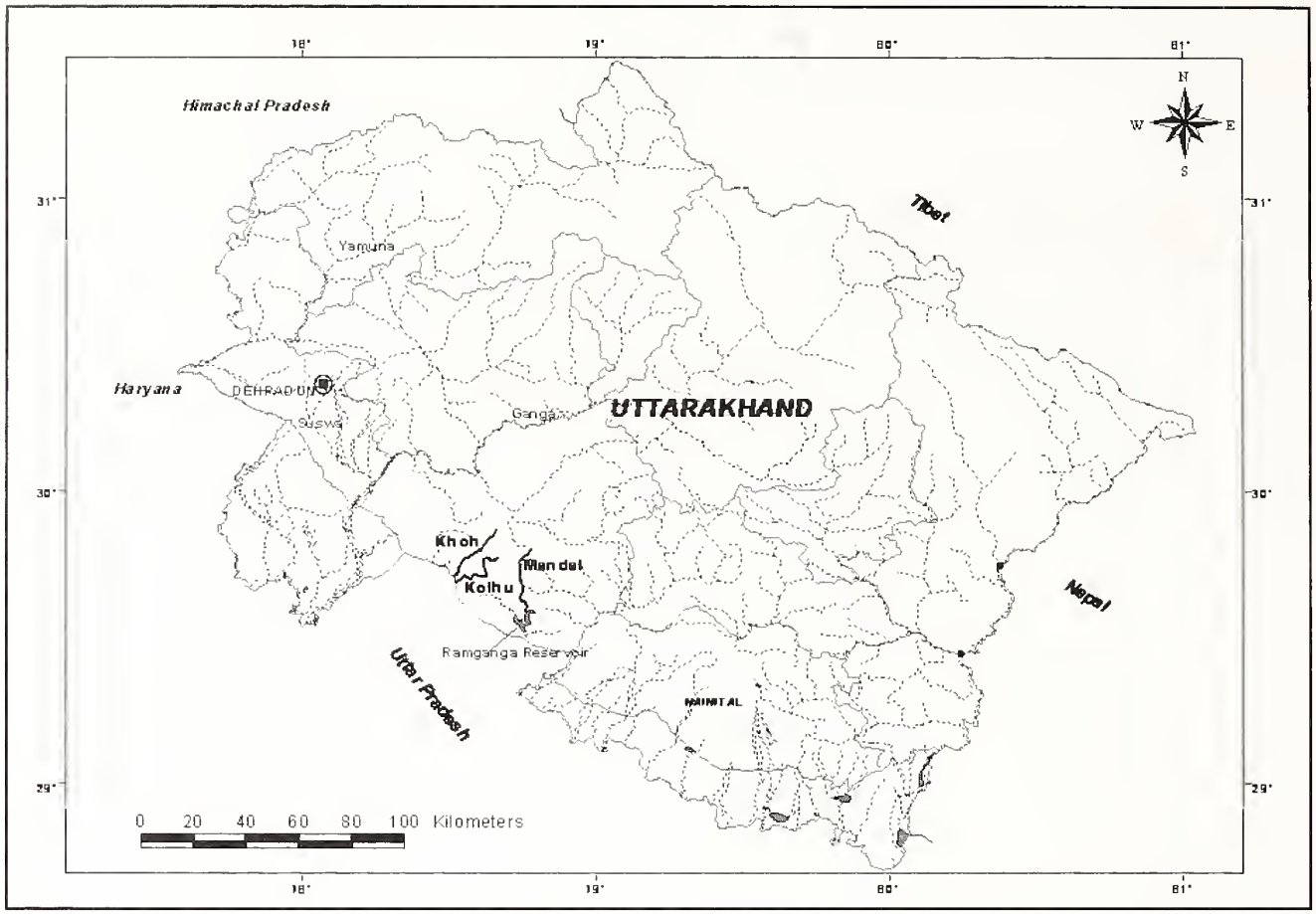

Fig. 1: Map of study river - Khoh, Kolhu and Mandal tributaries of the Ramganga river Uttarakhand, India

Length-weight relationship and condition factor were assessed from measurement of total weight (W) and total length (L). The general parabolic form of equation, $W = a L^b$, (where 'W' is weight of the fish in gm, 'L' is length in cm, 'a' is scaling constant, 'b' is allometric growth parameter) was used to show the statistical relationship between length and weight. Since the length-weight ratio is a power relationship, logarithms were used, so that the exponential relation could be expressed by a linear equation: Log W = log a + b log L. For each individual fish, regression was used to estimate the intercept (log a) and regression coefficient or slope *b* using SPSS (ver.8.0) programme.

Condition factor (Kn), assessed for comparisons among sites, was determined by the following expressions: $Kn = W/L^b$, where Kn corresponds to the condition factor and *b* is the allometry coefficient related with the form of the individuals growth, calculated from the length-weight relationship.

RESULTS

A total of 758 individuals were analyzed for length-weight relationship. The Golden Mahseer found were mostly juveniles to subadults in these rivers. The size class of 6-10 cm (total length) was dominant in all three rivers followed by 11-15 cm; 26-30 cm and above were caught only in Kolhu river. The mean fresh total length were Log 0.891 ± SE 0.009 in Khoh (Fig. 2), Log 0.997 ± SE 0.024 in Kolhu (Fig. 3) and Log 0.844 ± SE 0.003 in Mandal rivers (Fig. 4). Similarly, mean fresh body weight were Log 0.895 ± SE 0.018, Log 1.097 ± SE 0.052,

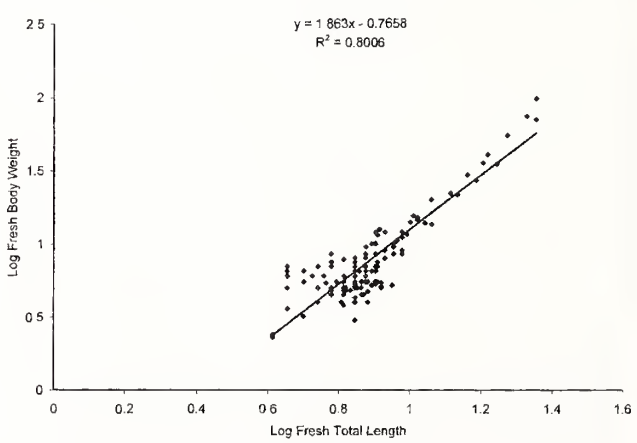

Fig. 2: Golden Mahseer in the Khoh river (n = 190)

Table 1: Showing detail description of Golden Mahseer *Tor putitora* in the tributaries of the Ramganga river

River	n	r	b	a	Kn	Log ln ± SE	Log wt ±SE
Khoh	190	0.80	1.86	-0.76	1. 108	0.891 ± 0.009	0.895 ± 0.018
Kolhu	70	0.87	2.016	-0.91	1.103	0.997 ± 0.024	1.097 ± 0.052
Mandal	498	0.55	1.76	-0.66	1.105	0.844 ± 0.003	0.821 ± 0.008

n – number of individuals, r – regression value, b - allometric growth parameter, a - scaling constant, Kn – condition factor assessed for comparison among sites, ln – length of fish, wt – weight of the fish

and Log 0.821 ± SE 0.008 respectively in these rivers.

There was no significant difference between rivers in respect of length-weight relationship of Golden Mahseer (One way ANOVA test, $F_{2,757} = 62.525$, $P<0.095$). The estimated regression coefficient, *b* was 1.863 in case of Khoh, 2.016 for Kolhu and 1.760 for Mandal rivers (see Figs. 2, 3, 4).

The condition factor of Golden Mahseer was better (i.e. Kn >3) in the size classes above 20-25 cm body length, but the condition factor of young ones, which were shorter than 20 cm in length, was poor and Kn value varied from 0.8 to 2.7 in these size classes. One-way ANOVA result shows that there were no differences in condition factor (Kn) of fishes in these three rivers ($F_{2,757} = 1.480$, $p > 0.05$, Table 1).

DISCUSSION

Tributaries of the Ramganga river of Lower Garhwal Himalaya were identified as one of the important mahseer areas (MacDonald 1936). However, the present study shows that upstream of River Ramganga, which largely falls in the buffer zone of the Corbett Tiger Reserve, Uttarakhand, also serves as an important spawning ground for the Golden Mahseer, as most of the fishes caught here were fingerlings and juveniles.

The length-weight relationship (W/L) and condition factor were observed for both the sexes of the Golden Mahseer in the Beas River System (Bali and Sharma 2000). Length-weight relationship of Golden Mahseer in other parts of Garhwal Himalaya (Nautiyal 1985a) is different from those in the upstream of Ramganga tributaries. This may be due to the different environmental factors.

The estimated condition factor for Golden Mahseer across rivers was similar, i.e. Kn = 1.10. It is quite far removed from the ideal condition factor, i.e. Kn = 3. This ideal situation applies if the study was conducted throughout one complete breeding cycle of fish, which includes all size classes from juvenile to adult. We found that the majority of the Golden Mahseer individuals caught were in juvenile stage, as the sampling period was after the spawning season. The result shows that the condition factor of adult Golden Mahseer (Kn) was better than the juveniles in the upstream of the Ramganga river. Juveniles are normally slender with a maximum length to weight ratio resulting in low Kn value (Hile 1936). Condition factor observed was similar in all rivers, but different from the standard Kn value. Further, various anthropogenic disturbances (sand mining and indiscriminate fishing) were also observed in the Kolhu and Khoh rivers.

Golden Mahseer is well known for its delicacy, sport angling and most importantly it is an umbrella fish species in Himalayan streams. It is an endangered Himalayan fish under continuous threat due to various anthropogenic pressures

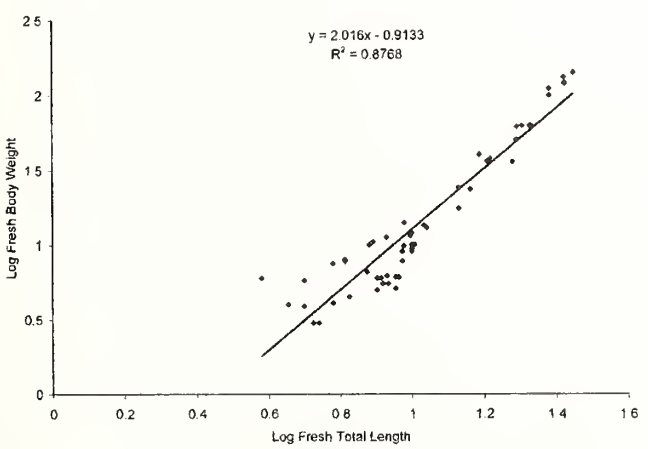

Fig. 3: Golden Mahseer in the Kolhu river (n = 70)

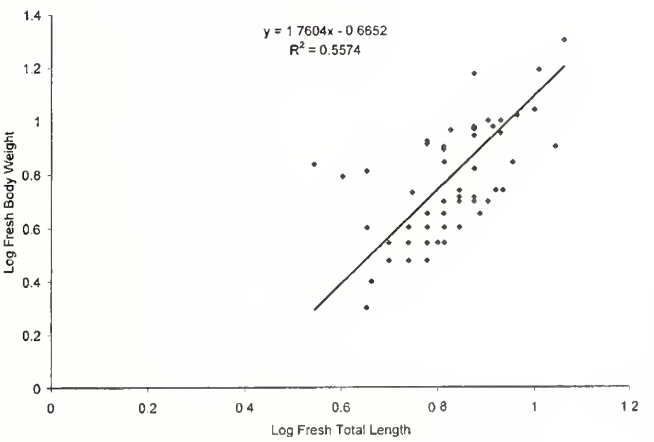

Fig. 4: Golden Mahseer in the Mandal river (n = 498)

(Nautiyal 1985b). The tributaries of the River Ramganga provide a good spawning ground for the Golden Mahseer, and hence need immediate protection.

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BIONOMICS OF A CRITICALLY ENDANGERED AND ENDEMIC CATFISH, *HORABAGRUS NIGRICOLLARIS* FROM ITS TYPE LOCALITY IN KERALA[1]

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Data on some aspects of the bionomics of the Bagrid Catfish *Horabagrus nigricollaris* are presented. The Imperial White-collared Catfish is confined to the regime reaches of its type locality – the Chalakudy river, Kerala and is listed as critically endangered. The present sample consists of specimens with a total length ranging from 70-187 mm and total weight ranging from 3.7-66.95 g. The growth was found to be allometric and the regression equation of combined sexes was log W= -1.839+2.855 log 'L'. *H. nigricollaris* is a benthophagic omnivore fish, feeding on insects, algae, and crustaceans. The absolute fecundity of a ripe specimen having a total length of 156 mm and weight 33.70 g was 1,320 eggs with a relative fecundity and GSI value of 413 eggs/g body weight and 9.5 respectively. The male:female sex ratio was 1:1.1. The information generated from this study is the first of its kind on the knowledge of the biology of this endemic catfish.

Key words: *Horabagrus nigricollaris*, endemic catfish, food and feeding habits, reproductive biology, length-weight relationship.

INTRODUCTION

Horabagrus nigricollaris (Pethiyagoda and Kottelat 1994) known as 'Manja koori' locally is confined to the type locality; Vettilapara (10° 17' N, 76° 32' E) in Chalakudy river, Kerala and is listed as Critically Endangered (CAMP Report 1998). It is a bottom inhabitant of the regime reaches of the stream with rocky and sandy/gravelly bed, well adapted to the cold, and free flowing waters of the river. The species is relished and generally consumed by the locals. The study made so far on this species is only on the description and taxonomic aspects by Pethiyagoda and Kottelat (1994), and Shaji and Easa (2003). Studies on biological aspects of the species are lacking therefore, some aspects of the biology such as length-weight relationship, food and feeding and reproductive biology are reported here.

MATERIAL AND METHODS

Fish samples for the present study were collected from the type locality, Vettilapara in Chalakudy river in Kerala from January, 2005 to December, 2005. A total of 48 specimens were collected from the local fishermen that were caught by diverse gears such as cast nets, gill nets, and hook and line. Being a nocturnal fish, fishing was carried out at night. In the rocky pools, hook and line and in the shallow region of regime reach the cast nets were used. Cast nets were hauled by walking through the stream a 100 m stretch throughout the sampling period. For hook and line, prawns caught from the same habitat were used as bait. Throughout the sampling period the catch/unit effort of the species was found to be very low, when compared to other species in the area. Usually the fishing time/duration was 2100 hrs – 0400 hrs at night. Specimens having a total length between 7.0 and 18.7 cm, and weight 3.7 to 66.95 g were examined during the study. Immediately after collection, the specimens were preserved in 10% formalin. The data of the length-weight relationship were analyzed following Le Cren (1961) by the formula, $W=aL^n$. The constants '*a*' and '*n*' in the equation were estimated using the method of least squares. The linear equation was fitted separately for males, females, indeterminate and the combined class. After taking the morphometric measurements such as total length, standard length, and total weight, the guts were dissected. The length, weight and volume of the gut were recorded and the contents taken out for food and feeding analysis. The gut contents were analyzed using Point's method described by Hynes (1950) and Pillai (1952). The index of preponderance was worked out following Natarajan and Jhingran (1961). Ovaries were removed from fresh specimens and their length and weight were recorded. They were then preserved in 10% formalin for ova diameter measurements and fecundity estimation. Excessive formalin was removed from preserved ovaries by washing with distilled water, when sufficiently hard the ovaries were weighed to the nearest milligram.

RESULTS

Length-weight relationship

Table 1 shows the corresponding statistics such as sample size (n), the length-weight ranges (minimum &

maximum), estimated parameters of length-weight relationships (*a*, *n*) and the standard error (SE) and r. Overall, parameters *n* ranged from a minimum of 2.657 for males to maximum of 2.934 for females. Fish samples were included throughout the sampling period, but the data are not representative of a particular season, consequently the parameters '*a*' and '*n*' should be treated as mean annual values. The length-weight relationship of the pooled data has been represented as Fig. 1.

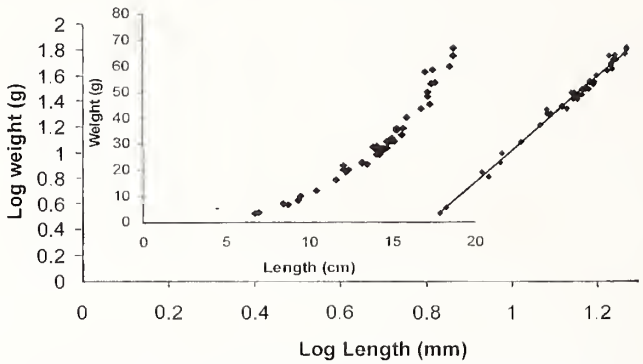

Fig. 1: Length-weight relationship of *Horabagrus nigricollaris*

Food and Feeding Habits

The alimentary canal of *H. nigricollaris* consists of the mouth, buccal cavity with a number of patches of teeth, well-developed stomach, moderately long intestine and rectum. The mouth is sub-terminal in position. The stomach contents include insects, algal remains, semi-digested animal and plant matter, fish molluscs and crustaceans. Insects could be identified from general exoskeletal characteristics. Larvae and nymphs were identified by the characteristic features of different groups. Only generic identification was possible. The insects mainly consisted of the adult, larvae and nymphs of Plectoptera (Stonefly larvae), Ephemeroptera (Mayfly larvae), Hemiptera (Notonecta), Dipterans and Coleoptera (beetles & water penny).The crustaceans consisted of prawns (*Palaemon* spp.) and appendages of crabs (*Barytelphusa* spp.). Molluscs were constituted by snails of the Family Viviparidae. Bits of leaves, fruits and tender shoots of aquatic plants, dried twigs and leaves of other plants that are occasionally washed off in the river waters and the decaying organic matter constituted the plant matter and detritus. The teleosts could be readily identified by the skeletal remains. Their specific identification often becomes difficult due to their being in advanced stages of digestion in the stomach. Besides the above food items, the presence of sand grains, mud and small pebbles in large quantities were noted. Ripe specimens examined during breeding season had almost empty guts. Index of preponderance worked out for *H. nigricollaris* is shown in Fig. 2.

Reproductive Biology

Each testis had numerous thin-walled lobules. During the breeding season the lobules became greatly distended with spermatids and spermatozoa. The ovaries are paired, rounded, elongated organs, which on attainment of full maturity, occupy nearly the entire body cavity. The two lobes of the ovaries gradually taper down towards the posterior extremity where they unite to form a short oviduct, which opens to the exterior, slightly behind the anal opening. The ovaries in mature condition were light orange. Subsequent to spawning the superficial blood vessels supplying the ovaries become enlarged and conspicuous. The smallest mature male and female collected in the present study had a size of TL=14,

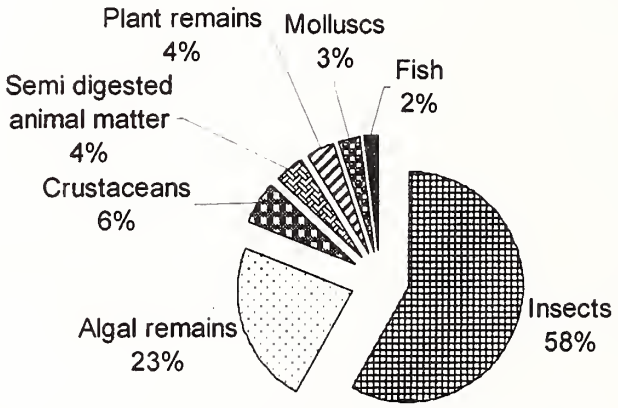

Fig. 2: Index of Preponderance of *Horabagrus nigricollaris*

Table 1: Coefficients of length-weight relationship and statistical analysis of *H. nigricollaris*

	Sample size (n)	Length range (cm)	Weight range (g)	'n'	log *a*	S.E.(b)	r	t	Sig.
Male	21	9.5-17.4	10-53.3	2.657	-1.610	0.092	0.989	28.980	0.000*
Female	23	9.4-18.7	8.4-66.95	2.934	-1.934	0.107	0.986	27.403	0.000*
Indeterminate	4	7.0-8.8	3.70-7.05	2.856	-1.846	0.382	0.983	7.481	0.032*
Combined	48	7.0-18.7	3.70-66.95	2.855	-1.839	0.046	0.994	62.167	0.000*

* = Significant at 5 % level.

TW=26.15 and TL=15.6, TW=33.70 respectively. Ripe males and females were collected only during January, February, November and December and hence it is concluded that the breeding season of the species is from November to February in this habitat. Most of the collected individuals had predominantly ripe ovaries from November-January. In February gravid fishes became less numerous. It can be inferred that the species is a total spawner and November-January is the spawning period of the species. The absolute fecundity of the ripe female of total length (TL) 15.6 cm and weight 33.70 g was 1,320 eggs, with a relative fecundity and GSI value of 39 eggs/g body weight and 9.5 respectively. The sex ratio of the male to female was 1:1.1. The mean ova diameter was 1.80 mm. The juveniles of the species were available from February onwards in the shallow stretches of the regime reaches during night and are easily vulnerable to simple fishing gears. Fingerlings (50-80 mm) have been collected by us from February to June in the vicinity of its microhabitat. The cyclic changes were studied in relation to different maturity stages. Qayyum and Qasim (1964a, b, c) and Bhatt (1971) were followed to observe the following maturity stages. The characters used for the classification of the ovary were appearance, colour, size, state of distension, relative space occupied in the body cavity, the size of the ova and their yolk content. In the case of testes, besides the general appearance, colour, size, etc., the extent of lobulation of the edges was used for determining the stage. Following maturity stages (Table 2) have been observed seasonally for *H. nigricollaris*.

DISCUSSION

The scrutiny of 'r' values showed very good correlation between length and weight. The exponent value '*n*' for males, females, indeterminate and combined class of *H. nigricollaris* in the present study was less than '3' indicating that increase in weight is relatively less compared to length. The growth in weight relative to length is allometric showing deviation from the 'cube law' (Le Cren 1951). From the above it may be seen that the value of '*n*' was higher in females, since the females have better condition and growth than the males. The value of exponent '*n*' for an ideal fish which maintains the same shape throughout its life cycle without any change, is equal to 3.0 (Allen 1938). According to Martin (1949), the value of exponent '*n*' in the parabolic equation usually lies within a range of 2.5-4.0. The change in exponent is due to changes in specific gravity and shape of the body contour and in such cases, the cube law need not always hold good. Morphological changes due to age also cause substantial changes in the exponent of length on weight. While discussing the merits of allometric growth formula, Beverton and Holt (1957) stated

Table 2: Gonadal condition of different maturity stage of male & female *H. nigricollaris*

No. of stages	Stages	Testis	Ovary
1	Immature	Very narrow, white, elongated, delicate and thread like testis. Left slightly longer than the right one.	Right and left ovaries more or less equal in length and size; colourless to whitish Eggs very minute, distinct only under microscope.
2	Maturing	More clear, pinkish white left lobe slightly longer than right. From each testis numerous finger like lobes arise.Occupies1/2 of the body cavity	Ovary considerably larger; yellowish white in colour; maturing eggs visible through wall under the microscope; left ovary longer than the right one.
3	Mature	Stages II & III cannot be distinguished clearly; both stages more or less similar the only difference is in the prominence of finger like lobes in the latter stage.	Reddish brown or yellow, shorter than fully mature ovary; differs from fully mature one in its colour (quite yellowish to orange in case of fully mature ovary)
4	Fully mature or Ripe	Testes become more elongated and extend over the entire visceral cavity. Creamy white in colour.	Yellowish to orange; ovaries visible through the translucent body wall of abdomen from outside; one or two ripe eggs remain in the oviduct. Mean ova diameter 1.8 mm.
5	Spent	Colour fades; testes seem to be dorsoventrally flattened. Occupy ½ to ¾th of the visceral cavity.	Colour fades; ovary elongated but shrunken and slightly wrinkled. A number of immature and a few mature yellow eggs still remaining in nearly empty bag; ovarian wall transparent.

that instances of important deviation from isometric growth in fishes are rare. In the present study, deviation from the isometric value of '3' was evident, and such deviations from the isometric value of '3' have also been reported in many fin fishes.

Insects were the dominant food item contributing 59% of the total gut content. The second major item is the algal remains contributing 23% followed by crustaceans, semi-digested animal matter, plant matter, molluscs, fish in the ratio of 5.8%, 3.7%, 3.6%, 2.7%, 2.2% respectively. In general, the gut contents of animal origin contributed the major share (73%) followed by material of plant origin (24%) and the rest by others. The dense overhanging vegetation of the forest habitat is an important allochthonous source of food particularly insects, fruits and larval forms of fish. In addition, the leaf litter supports large numbers of aquatic insects, gastropod molluscs and young fish. The occurrence of scales along with fish remains shows that the species often feeds on fish probably on dead or decaying fish. Sand and mud are accidentally taken while feeding on other food items particularly insects and crustaceans. The presence of sand and mud in the stomach also indicates the bottom feeding habit of the fish.

H. nigricollaris possesses a well-marked single group of oocytes and the breeding season is short and lasts for about four months. According to Qasim and Qayyum (1961) in fishes which possess single group of oocytes during the breeding season, the cycle of spawning in each individual occurs only once a year and the state of maturity at any given time is fairly uniform throughout the population. In the ovaries of fishes which spawn only once a year and in which the duration of spawning is restricted to a definite and short period, the mature stock of ova can be differentiated from the general egg stock; ovary has only one batch of mature eggs to be shed during the succeeding spawning season. Fecundity of any species of fish depends not only upon the size and age of the fish, but also on the size of the egg. The fish in which the eggs are larger, the fecundity will be lower when compared to fish with smaller eggs. According to Svardson (1949) larger larvae produced from larger eggs have a better chance in natural selection than smaller larvae produced from smaller eggs.

The length-weight relation clearly indicates that the Imperial White-collared Catfish follows allometric growth in its type locality in Chalakudy river. From the above observations it can be concluded that *H. nigricollaris* is a benthophagic omnivore showing preference towards animal diet. *H. nigricollaris* possesses a well-marked single group of oocytes and the breeding season is short and lasts for about four months (November to February). The conservation actions needed include judicious exploitation of the fish stocks, artificial propagation and regular ranching programmes and also enforcement and declaration of closed season during the breeding season. The protective measures include protection of riverine pools and crevices which act as the microhabitat of the species. Urgent attention to declare certain rocky pools and crevices as sanctuaries is essential as the species is on the verge of extinction.

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ICTHYOFAUNAL CONTRIBUTION TO THE STATE AND COMPARISON OF HABITAT CONTIGUITY ON TAXONOMIC DIVERSITY IN SENKHI STREAM, ARUNACHAL PRADESH, INDIA[1]

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The Eastern Himalayan region has been identified as one of the 18 mega-biodiversity 'hotspot' areas of the world (Myers *et al.* 2000). Arunachal Pradesh constitutes 60.93% of the Eastern Himalayan region. Some documentation exists on the flora, but documentations on faunal aspects are still scanty, with scattered reports, mostly on birds and some large mammals. Although contributions to the fish fauna of the State have also been made, accounts of species compositions of many water bodies still remain undocumented awaiting explorations and studies of such aquatic systems. Descriptions of most faunal works have been added with special emphasis on fishes. The preliminary findings suggest 7 first reports for the district and 3 first reports for the State. Senkhi stream contributed 31.37% of the icthyofaunal families of the district and 29.52% of genera while the species representation was found to be 27.32%. The correlation matrix reveals an interesting fact that Dikrong and Pachin have more common species than Senkhi, which is a hill stream. The striking feature is the even distribution of species under family Badidae, Psilorhynchidae and Olyridae though their contribution of each lotic (Senkhi, Pachin and Dikrong) water body is merely a single species and hence these species will be most vulnerable once a mega dam comes in-between, restricting the migration of already threatened population.

Keywords: Eastern Himalaya, Arunachal Pradesh, Lotic, Icthyofauna

INTRODUCTION

Myers *et al.* (2000) identified 18 mega-biodiversity 'hotspot' regions of the world, based on the criterion of exceptional concentration of species and endemism as well as exceptional degrees of threat arising out of increased pressures of human intervention, with the possibility of potential extinction of constituent species caused by the latter. Myers *et al.* (2000) predicted the possibility of a major extinction spasm impending in these areas. However, they also pointed out that if key localities of biotic richness can be identified, conservation priorities could be determined in a more informed and methodological manner than has been the case (Mittermeier *et al.* 1999 and Myers *et al.* 2000). The principal drawback, however, has been the lack of basic data, especially of animal species.

Out of the 18 'hotspots' the Eastern Himalayan region was assessed to have an 'ultra-varied' topography, a factor thought to be the working principle which fosters species diversity and endemism. However the lack of data, particularly of species number and distribution, seems especially acute for this region with large parts remaining unexplored scientifically.

The state of Arunachal Pradesh, stretching from 26° 30' to 29° 30' N and 91° 30' to 97° 30' E, falls within the Eastern Himalayan region. In fact, Arunachal Pradesh, with a total geographical area of 83,743 sq. km, constitutes a substantial proportion of this mega-biodiversity 'hotspot' region. It is known for its topographic and altitudinal diversity, its rich forests and numerous riverine bodies. Among the constituents of the Eastern Himalayan Hotspot region (Nepal, Bhutan and Yunnan in China), Arunachal Pradesh probably still retains the highest forest cover. Given the low density of human population and difficult terrain, many of its forests and rivers remain pristine and undisturbed. Inaccessibility, arising out of the attributes of topography and climate, has helped to conserve the natural resources of the State, but this has also meant that the rich biological resources of the State remain largely undocumented.

In context of Arunachal Pradesh, the efforts made by governments (both State and Central) for the development of the state and its populace has been relatively slow as compared to other parts of country. There is urgency for extensive studies on biodiversity related issues keeping in mind the immense bioresources of Arunachal Pradesh. One of the immediate visible signs of development efforts in Itanagar, the capital, is the rapid urbanization and spread of settlements which have adverse effects on the flora and fauna

of a given location. Apart from the local extinction of biological elements consequent to permanent changes of land use, urbanization also has its deleterious impact on the water bodies. The disposal of urban waste into water bodies, removal of sand, boulders and stones change the micro-habitats of the stream and bring about a consequent depletion of species inhabiting such systems. Arunachal's network of riverine systems offers tremendous potential for hydro-power generation. Each hydro-power project involves the construction of major dams. The impact of such major changes on the resident biological elements is well known and contributes to the depletion of biodiversity. It is imperative, therefore, to carry out extensive documentations so that baseline data and information are generated, thereby contributing to conservation strategies and prioritization of ecological (and evolutionary) sensitive locations.

So far as icthyofauna is concerned, the earliest report seems to be of McClelland (1839) who mentioned four species from Lohit (Mishmi hills) in his account of Indian Cyprinids. This is followed by Chaudhuri (1913) who reported 21 species from the State. Hora (1921), Jayaram (1963), Jayaram and Mazumdar (1964), Srivastava (1966), Dutta and Sen (1977), Dutta and Barman (1984, 1985), Sen (1985), Sen (1999), and Nath and Dey (2000) are the other workers who have contributed to the fish fauna of the State. The reports of the above workers are accounts from different parts of Arunachal Pradesh and cover West Kameng, Upper and Lower Subansiri, East and West Siang, Lohit, Tirap and Changlang districts of Arunachal Pradesh. While reports on the icthyofauna seems to cover the State fairly well, gaps remain in regard to a complete coverage of a given drainage system and the reports do not give accounts of seasonal variations of the fish fauna from a given location. While surveys can provide an indication of species diversity of the given location at a given time, they fail to provide an indication of seasonal fluxes and hence, fail to record species with seasonal immigration into the system. The present investigation was conducted in Senkhi stream, a lotic system that drains into the Brahmaputra through the Pachin and Dikrong rivers. Regular monitoring of species diversity and richness has been initiated from September 14, 2004 and the present report is a compilation based on the thirteen months monitoring.

METHODOLOGY

Weekly samples were collected from three permanent sites on the Senkhi stream, using a cast net of 0.007 m mesh size and radius of 2.29 m. Samplings were done after dusk (from 1800 to 2200 hrs, except for one occasion, when sampling was carried out between 0100 and 0400 hrs). To supplement the above efforts, regular sampling was also done on a 5 km stretch in order to assess the species diversity found in catches from the study sites. It may be worth mentioning that the 5 km stretch was abandoned after 52 weeks of sampling and hence was termed as non regular, while the study was continued in the regular sampling sites till November 14, 2005. The species diversity reported here includes all the samplings outlined. Taxonomic identification used here follows those reported by Jayaram (1999). Representatives have been preserved and deposited in the NE Unit's office and this is supplemented with photographic documentation of each species, taken on the day of the catch. Senkhi, Dikrong and Pachin are contiguous water bodies (Fig. 1), there is no barrier for migration of fishes from each water body to other. Assuming that all fishes have equal chances of migration to and fro from all the three water bodies, the taxonomical enumeration of fishes of all the three water bodies can be used to find effect of contiguity on taxonomic diversity. Senkhi form the uppermost part of the water body and was sampled by us; however at mid elevations Pachin and lower plain river Dikrong was sampled by Nath and Dey 2000. Therefore, present enumeration of fishes was subjected to comparison with that of Nath and Dey 2000 to asses the effect of habitat contiguity on taxonomic distribution of fishes. The species were compared for their correlation matrix in all three lotic water bodies using Statsoft 2001, also their higher taxa appropriation was calculated corresponding to each lotic water body.

RESULTS

The icthyofaunal diversity of the study site is restricted to 47 species belonging to 31 genera, spread over 16 families (Table 1). The species diversity listed is the cumulative total of fifty two regular samplings spread over a time period of thirteen months beginning September 14, 2004. The frequency of occurrence of each species was calculated based on the number of occasions the species was collected during the samplings. The results presented in Table 1, suggest that of the 47 species collected, 3 species belonging to the families Cyprinidae, Cobitidae and Psilorhynchidae were common in the study sites. The analysis also indicates that 9 more species, belonging to Cyprinidae, Sisoridae, Channidae, Bagridae, and Cichlidae, are rare. Of these, three species – *Glyptothorax telchitta*, *Labeo gonius*, and *Oreochromis mossambica* – are extremely rare, having been collected only once during the whole study period. It is important to note, however, that the occurrence of *Oreochromis mossambica* in the lotic system may be accidental and a result of introduction through flood waters from fishery ponds nearby where they occur as a common culture fishery species. Thus, although

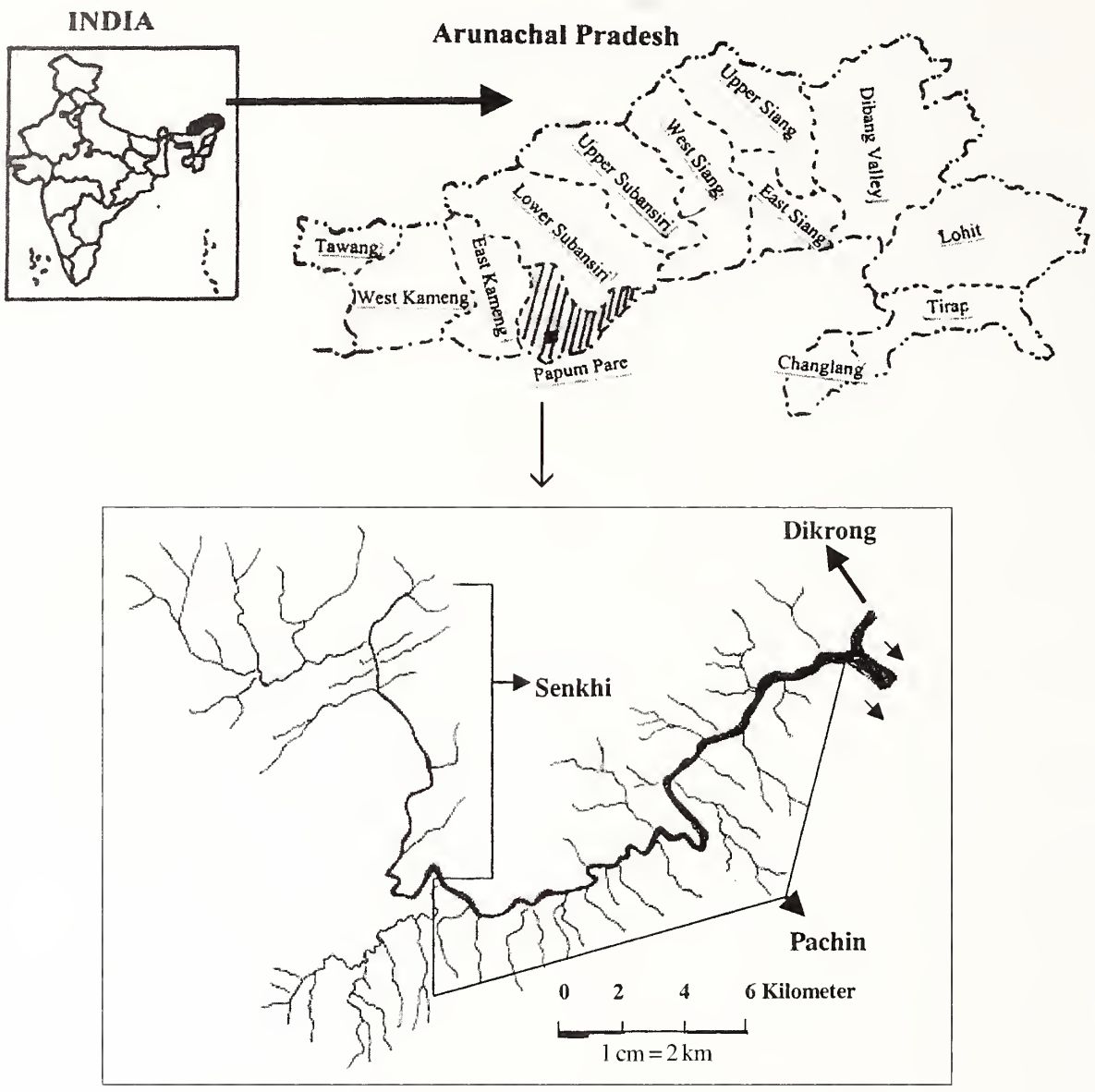

Fig. 1: Map of Itanagar, Papum Pare districts, showing Senkhi, Pachin and Dikrong

the species is included in all the assessments reported subsequently, it must be considered as an accidental migrant not normally native to such systems.

An analysis of the taxonomic composition of the fish fauna suggests Cyprinidae to be the most dominant family with 22 representative species (43%) occurring in the study site. Cobitidae, the next dominant family, has 6 species inhabiting the site (17%), followed by Sisoridae with 3 representative species (10%). Whereas Amblycepitidae, Psilorhynchidae, Homalopteridae, Heteropneustidae, Chandidae, Channidae, Clariidae, Cichlidae, Olyridae, Badidae, Erethistidae and Bagridae are the other 12 families each having single species representation.

In addition to the 47 species reported above, another 11 species belonging to 8 genera, spread over 6 families were also caught during the single survey of a 5 km stretch downstream from the study site. The species caught during this survey are listed in Table 1. The taxonomic diversity in this catch shows a co-dominance of the families Cyprinidae and Cobitidae, with 7 species representation (70%). Cobitidae, Clariidae and Mastacembelidae with 1 species each (30%) follow next.

The higher taxa diversity, on combining of the results of the two sample sets, shows an interesting transformation. While Family Cyprinidae with 22 species (48%) retains its predominance, Cobitidae follows as a poor second with

Table 1: Fish catch frequency corresponding to their status in the Senkhi stream, Papum Pare

Sl.No	Scientific name	Catch frequency (%)	Status
1	*Barilius bendelisis* Hamilton	100	Common
2	*Aborichthys elongatus* Hora	92.3	Common
3	*Psilorhynchus balitora* Hamilton	92.3	Common
4	*Tor tor* Hamilton	88.5	Abundant
5	*Garra gotyla gotyla* Gray	80.8	Abundant
6	*Garra annandalei* Hora	78.8	Frequent
7	*Acrossocheilus hexagonolepis* McClelland	71.2	Frequent
8	*Schistura devdevi* Hora	67.3	Frequent
9	*Botia rostrata* Gunther	65.4	Frequent
10	*Barilius tileo* Hamilton	51.9	Occasional
11	*Semiplotus semiplotus* McClelland	48.1	Occasional
12	*Danio aequipinnatus* McClelland	40.4	Occasional
13	*Crossocheilus latius latius* Hamilton	36.5	Occasional
14	*Hara hara* (Hamilton)	36.5	Occasional
15	*Glyptothorax pectinopterus* Menon ●	34.6	Occasional
16	*Chagunius chagunio* Hamilton	34.6	Occasional
17	*Balitora brucei* Gray †	32.7	Occasional
18	*Botia dario* (Hamilton)	30.8	Occasional
19	*Puntius conchonius* Hamilton	25	Occasional
20	*Barilius barna* (Hamilton)	25	Sporadic
21	*Danio dangila* (Hamilton) *	23.1	Sporadic
22	*Acanthocobitis botia*(Hamilton)	15.4	Sporadic
23	*Danio devario* (Hamilton) *	15.4	Sporadic
24	*Glyptothorax brevipinnis* Hora ●	11.5	Sporadic
25	*Heteropneustes fossilis* (Bloch)	9.6	Rare
26	*Puntius sophore* (Hamilton) *	9.6	Rare
27	*Puntius ticto* Hamilton	7.7	Rare
28	*Lepidocephalus guntea* (Hamilton) *	7.7	Rare
29	*Channa orientalis* (Schneider)	5.8	Rare
30	*Oreichthys cosuatis* Hamilton ●	5.8	Rare
31	*Barilius bola* (Hamilton)	5.8	Rare
32	*Puntius chola* (Hamilton)	5.8	Rare
33	*Parambassis ranga* Hamilton*	5.8	Rare
34	*Aspidoparia jay* (Hamilton)	3.8	Extremely rare
35	*Olyra longicaudata* (McClelland) *	3.8	Extremely rare
36	*Amblyceps arunachalensis* Nath & Dey	3.8	Extremely rare
37	*Chanda nama* (Hamilton) *	3.8	Extremely rare
38	*Clarias batrachus* (Linnaeus) *	3.8	Extremely rare
39	*Labeo gonius* Hamilton ●	1.9	Extremely rare
40	*Mystus montanus* Jerdon	1.9	Extremely rare
41	*Oreochromis mossambica* Gray † ●	1.9	Extremely rare
42	*Glyptothorax telchitta* Hamilton † ●	1.9	Extremely rare
43	*Mastacembelus armatus* (Lecepede) *	1.9	Extremely rare
44	*Badis badis* (Hamilton)	1.9	Extremely rare
45	*Glyptothorax cavia* (Hamilton) ●	1.9	Extremely rare
46	*Brachydanio rerio* (Hamilton) *	1.9	Extremely rare
47	*Labeo dero* (Heckel) *	1.9	Extremely rare

Catch frequency with-Common: 91-100%, Abundant: 81-90%, Frequent: 61-80%, Occasional: 31-59%, Sporadic: 15-30%, Rare: 05-14%, Extremely rare: <05%, *: represents the species caught outside the regular sampling site; †: represents the first report for the state; ●: represents first report for the district

6 representative species, contributing 13% to the species composition. The Family Sisoridae, with 4 species, contributes 9% to the icthyofaunal diversity, followed by Mastacembelidae and Chandidae with 2 species at 4% contribution each. Families Amblycipitidae, Badidae, Bagridae, Channidae, Cichlidae, Clariidae, Sisoridae, Heteropneustidae, Homalopteridae, Olyridae, and Psilorhynchidae, were each represented by a single species, thereby contributing a mere 2% to the higher taxa diversity of the lotic system (Table 3). An interesting aspect of the composition is the restrictive

Table 2: Comparison of Icthyofauna of three lotic bodies in the Papum Pare district

Species	Family	Dikrong	Pachin	Senkhi
Aboricthys elongatus Hora	Cobitidae	+	+	+
Aboricthys kempi Chaudhuri	Cobitidae	+	+	-
Acanthocobitis botia (Hamilton)	Cobitidae	+	+	+
Acrossocheilus hexagonolepis (McClelland)	Cyprinidae	+	+	+
Amblyceps apangi Nath & Dey	Amblycipitidae	+	-	-
Amblyceps arunachalensis Nath & Dey	Amblycipitidae	+	-	+
Amblyceps mangois (Hamilton)	Amblycipitidae	+	+	-
Amblypharyngodon mola (Hamilton)	Cyprinidae	+	-	-
Anabas testudineus Bloch	Anabantidae	+	-	-
Anguilla bengalensis (Gray & Hardwicke)	Anguillidae	+	-	-
Aspidoparia jaya (Hamilton)	Cyprinidae	+	-	+
Aspidoparia morar (Hamilton)	Cyprinidae	+	-	-
Badis badis (Hamilton)	Badidae	+	+	+
Bagarius bagarius (Hamilton)	Sisoridae	+	+	-
Balitora brucei Gray	Homalopteridae	-	-	+
Barilius barna (Hamilton)	Cyprinidae	+	+	+
Barilius bendelesis (Hamilton)	Cyprinidae	+	+	+
Barilius bola (Hamilton)	Cyprinidae	+	+	+
Barilius tileo (Hamilton)	Cyprinidae	+	+	+
Barilius vagra (Hamilton)	Cyprinidae	+	-	-
Botia dario Hamilton	Cobitidae	+	+	+
Botia rostrata Gunther	Cobitidae	+	+	+
Chagunius chagunio (Hamilton)	Cyprinidae	+	+	+
Parambassis baculis Hamilton	Chandidae	+	+	-
Chanda nama (Hamilton)	Chandidae	+	+	+
Parambassis ranga Hamilton	Chandidae	+	+	+
Channa marulius (Hamilton)	Channidae	+	-	-
Channa orientalis Schneider	Channidae	+	+	+
Channa punctatus (Bloch)	Channidae	+	-	-
Channa striatus (Bloch)	Channidae	+	-	-
Chela laubuca (Hamilton)	Cyprinidae	+	-	-
Cirrhinus reba (Hamilton)	Cyprinidae	+	-	-
Clarias batrachus (Linnaeus)	Claridae	+	-	+
Crossocheilus latius latius (Hamilton)	Cyprinidae	+	+	+
Danio aequipinnatus (McClelland)	Cyprinidae	+	+	+
Danio dangila (Hamilton)	Cyprinidae	+	-	+
Danio devario (Hamilton)	Cyprinidae	+	-	+
Brachydanio rerio (Hamilton)	Cyprinidae	+	+	+
Erethistes pussilus Muller & Troschel	Erethistidae	+	-	-
Garra annandalei Hora	Cyprinidae	+	+	+
Garra gotyla gotyla (Gray)	Cyprinidae	+	+	+
Garra kempi Hora	Cyprinidae	+	-	-
Garra lissorhynchus (McClelland)	Cyprinidae	+	-	-
Garra mcclellandi (Jerdon)	Cyprinidae	+	+	-
Glossogobius giuris (Hamilton)	Gobiidae	+	-	-
Glyptothorax brevipinnis Hora	Sisoridae	-	-	+
Glyptothorax cavia (Hamilton)	Sisoridae	-	-	+
Glyptothorax pectinopterus (McClelland)	Sisoridae	-	-	+
Glyptothorax telchitta Hamilton	Sisoridae	-	-	+
Gudusia chapra (Hamilton)	Clupeidae	+	-	-
Hara hara (Hamilton)	Erethistidae	+	-	+
Heteropneustes fossilis (Bloch)	Heteropneustidae	+	-	+
Labeo dero (Heckel)	Cyprinidae	+	+	+
Labeo pangusia (Hamilton)	Cyprinidae	+	+	-
Lepidocephalus annandalei Hora	Cobitidae	+	+	-
Lepidocephalus guntea (Hamilton)	Cobitidae	+	+	+

Table 2: Comparison of Icthyofauna of three lotic bodies in the district (*contd.*)

Species	Family	Dikrong	Pachin	Senkhi
Macrognathus aral (Bloch & Schneider)	Mastacembelidae	+	-	-
Mastacembelus armatus (Lacedepe)	Mastacembelidae	+	+	+
Macrognathus pancalus (Hamilton)	Mastacembelidae	+	-	+
Monopterus cuchia (Hamilton)	Synbranchidae	+	-	-
Mystus bleekeri (Day)	Bagridae	+	-	-
Mystus cavasisus (Hamilton)	Bagridae	+	-	-
Mystus montanus (Jerdon)	Bagridae	+	-	+
Mystus vittatus (Bloch)	Bagridae	+	-	-
Nandus nandus (Hamilton)	Nandidae	+	-	-
Shistura arunachalensis Dutta & Barman	Cobitidae	+	-	-
Shistura devdevi Hora	Cobitidae	-	-	+
Shistura sikmaiensis Hora	Cobitidae	+	-	-
Notopterus notopterus (Pallas)	Notopteridae	+	-	-
Olyra longicaudata (McClelland)	Olyridae	+	+	+
Ompok pabda (Hamilton)	Siluridae	+	-	-
Ompok pabo (Hamilton)	Siluridae	+	-	-
Pillaia indica Yazdani	Pillaiidae	+	-	-
Psilorhynchus balitora (Hamilton)	Psilorhychidae	+	+	+
Puntius chola (Hamilton)	Cyprinidae	+	+	+
Puntius conchonius (Hamilton)	Cyprinidae	+	+	+
Puntius sarana sarana (Hamilton)	Cyprinidae	+	-	-
Puntius sophore (Hamilton)	Cyprinidae	+	+	-
Puntius ticto (Hamilton)	Cyprinidae	+	+	+
Rasbora daniconius (Hamilton)	Cyprinidae	+	-	-
Rasbora elanga (Hamilton)	Cyprinidae	+	-	-
Rasbora rasbora (Hamilton)	Cyprinidae	+	-	-
Salmostoma bacaila (Hamilton)	Cyprinidae	+	-	-
Schizopyge esocinus (Heckel)	Cyprinidae	-	+	-
Schizothorax richardsonii (Gray)	Cyprinidae	+	+	-
Semiplotus semiplotus (McClelland)	Cyprinidae	+	+	+
Silurus afgana (Gunther)	Siluridae	+	-	-
Somileptes gongota (Hamilton)	Siluridae	+	-	-
Oreochromis mossambica (Peters)	Cichlidae	-	-	+
Tor putitora (Hamilton)	Cyprinidae	+	-	-
Tor tor (Hamilton)	Cyprinidae	+	+	+
Wallago attu (Schneider)	Siluridae	+	-	-
Xenentodon cancila (Hamilton)	Belonidae	+	+	-
Oreicthys cosuatis (Hamilton)	Cyprinidae	-	-	+
Labeo gonius (Hamilton)	Cyprinidae	-	-	+

'+' indicates presence of species; '-' indicates absence of species(s)

distribution of certain families even within the localized sampling area. Species of Mastacembelidae and Olyridae seem restricted to the lower stretches of Senkhi stream as they do not figure in the catches from the study site upstream.

Table 3: Total taxa in all three water bodies

Taxa	Water bodies		
	Dikrong	Pachin	Senkhi
Family	24	11	16
Genus	49	25	31
Species	85	40	47

Conversely, representatives from Psilorhynchidae, Homalopteridae, Heteropneustidae, Channidae and Bagridae seem confined to the upper stretches of Senkhi stream Thus, on a higher taxa level, while members of Cyprinidae are the most common and contribute most to the diversity of this lotic system, Psilorhynchidae, Homalopteridae, Heteropneustidae, Channidae and Bagridae appear to be taxonomic groups with both restricted diversity and distribution in this system.

There were in all 95 species (Table 2) in all the three lotic water bodies out of which Dikrong had 85 species

Table 4: Total taxa exclusive to Dikrong, Pachin and Senkhi

Taxa	Water bodies		
	Dikrong	Pachin	Senkhi
Family	10	-	3
Genus	18	1	3
Species	37	1	9

Table 5: Total taxa common to Dikrong, Pachin and Senkhi

Taxa	Water bodies		
	Dikrong	Pachin	Senkhi
Family	8	6	9
Genus	20	10	8
Species	29	10	9

(89.47%), followed by Senkhi with 47 species (49.47%) and lastly by Pachin with 41 species (43.16%). There are 29 species under 20 genera and 8 families which were common to all the three lotic bodies and hence can be considered as migratory elements. While there were 47 species which showed exclusive distribution, out of which Dikrong shared the maximum 37 species with 78.72% contribution while Senkhi shared the second slot with 9 species corresponding to 19.15% share while Pachin was far behind in having 1 species with mere 2.13% contribution (Tables 3, 4, 5).

The correlation matrix analysis showed that there is a positive correlation between Dikrong and Pachin at 95% CI, which can be attributed to the taxa having lower altitudinal distribution. While Senkhi and Dikrong showed a negative correlation at 95% CI, which may be due to more of species having adaptation to the high current waters. While the species in the Senkhi stream and Pachin have positive correlation at 95% CI, which is attributed to the migratory nature of the fishes common to these two lotic water bodies. Hence, it can be said that Dikrong and Pachin had more of common elements than Senkhi.

Table 6: Taxonomic diversity of Icthyofauna in the three lotic systems

Family	Lotic bodies					
	Dikrong		Pachin		Senkhi	
	Gen.	Sp.	Gen.	Sp.	Gen.	Sp.
Amblycipitidae	1	3	1	1	1	1
Anabantidae	1	1	-	-	-	-
Anguillidae	1	1	-	-	-	-
Badidae	1	1	1	1	1	1
Bagridae	1	4	-	-	1	1
Belonidae	1	1	1	1	-	-
Chandidae	1	3	1	3	1	2
Channidae	1	4	1	1	1	1
Cichlidae	-	-	-	-	1	1
Clariidae	1	1	-	-	1	1
Clupeidae	1	1	-	-	-	-
Cobitidae	6	10	4	7	5	6
Cyprinidae	17	37	12	22	12	22
Gobiidae	1	1	-	-	-	-
Heteropneustidae	1	1	-	-	1	1
Homalopteridae	-	-	-	-	1	1
Mastacembelidae	2	3	1	1	1	2
Nandidae	1	1	-	-	-	-
Notopteridae	1	1	-	-	-	-
Olyridae	1	1	1	1	1	1
Pillaiidae	1	1	-	-	-	-
Psilorhynchidae	1	1	1	1	1	1
Siluridae	3	4	-	-	-	-
Sisoridae	1	1	1	1	1	4
Synbranchidae	1	1	-	-	-	-
Erethistidae	2	2	-	-	1	1

Gen.: Genus, Sp.: Species

The higher taxa appropriation in all the three lotic water bodies was carried out (Table 6). The striking feature is the absence of the Cichlid family from the lower plain rivers, namely Dikrong and Pachin, it may be mentioned that such cases may be treated as accidental (exotic species) as they may have escaped from nearby culture fishery reservoir. Families like Cyprinidae contribute 45.68% in Dikrong, 27.16% of Pachin and Senkhi respectively and Cobitidae (43.48% in Dikrong, 30.43% in Pachin and 26.09% of Senkhi), which contributes to the largest number of the species in all the three lotic water bodies may be termed as true freshwater Icthyo-families.

DISCUSSION

Senkhi, Dikrong and Pachin constitute three contiguous water bodies of Papum Pare district of Arunachal Pradesh. The district harbours one of the most urbanized centres in the State as 15.7% of the people are urban. The anthropogenic pressure coupled with the developmental aspiration of state capital, Itanagar has done more harm to the ambient water bodies. The present enumeration reveals that district holds 59.37% of the state icthyofauna (Jayaram 1964; Nath and Dey 2000; Dutta and Barman 1985; Srivastava 1966; Sen 1999).

Three new reports have been added to the state, namely *Balitora brucei*, *Glyptothorax telchitta* and *Oreochromis mossambica*. It may be worth mentioning that *Oreochromis mossambica* is an exotic species, and hence may be accidental or introduced, such species needs good quarantine as it is known to be a voracious predator. There were 29 species that are common to all the three water bodies, and hence can be termed as migratory elements. Dikrong leads the tally with highest number of exclusive taxa 78.72% (lower floodplain elements) followed by Senkhi 19.15% (hill stream elements).

The comparative study reveals that Dikrong and Pachin have more common species than Senkhi, which is obviously a hill stream. It follows an interesting trend that the Chandidae and Mastacembelidae are also in continuous distribution in the lotic habitat though their species contribution is 8 and 5 respectively. Families like Clupeidae, Notopteridae, Gobiidae and Synbranchidae have distribution only confined to Dikrong, and hence can be treated as lowland riverine families (Das *et al.* 2002). *Balitora brucei* is the only Homalopterid not found in the Dikrong and Pachin. It may be mentioned that this is a true hill stream species. The Sisorids diversity in the hill stream of Senkhi is also a marked feature, which is attributed to adaptative radiation of these catfishes to the high current water (Hora 1922; Tilak 1976; de Pinna 1996). Striking feature is the even distribution of species under families Badidae, Psilorhynchidae and Olyridae, though their contribution to each lotic water body is merely a single species, and hence these species will be most vulnerable once a mega dam comes between restricting the migration of already threatened population.

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FOOD HABITS OF LEOPARD (*PANTHERA PARDUS FUSCA*), DHOLE (*CUON ALPINUS*) AND STRIPED HYENA (*HYAENA HYAENA*) IN A TROPICAL DRY THORN FOREST OF SOUTHERN INDIA[1]

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Food habits of the Leopard (*Panthera pardus fusca*) were studied in the Sigur (Nilgiri district) and Thalamalai (Erode district) Reserve Forests of Tamil Nadu, southern India from June to October 1997. A comparison of Leopard food habits with the diet of the co-predators, Dhole (*Cuon alpinus*) and Striped Hyena (*Hyaena hyaena*), in the study area was carried out to understand niche overlaps. Chital (*Axis axis*) was the major prey of the Leopard in both areas; found in 40% leopard scats in the highly disturbed area (HDA) and 65% in the less disturbed area (LDA). Other important prey species were Sambar (*Cervus unicolor*), Blackbuck (*Antilope cervicapra*), Black-naped Hare (*Lepus nigricollis*), Indian Wild Boar (*Sus scrofa*), Indian Porcupine (*Hystrix indica*), Common Langur (*Semnopithecus entellus*) and Indian Peafowl (*Pavo cristatus*). The Leopard had a wider niche-breadth value in the highly disturbed (0.32) than in the LDA (0.20). The food niche of the three predators – Leopard, Dhole and Striped Hyena overlapped considerably. Niche-overlaps were higher in the less disturbed than in the HDA. Prey preference estimates showed that the most favoured prey of the Leopard was Chital. Domestic livestock formed a sizeable portion of the Leopard diet in both areas; more in the highly disturbed (33.3%) compared to the less disturbed (14.7%). Twenty cases of livestock kills by Leopards were recorded during the 5-month study. Anthropogenic pressure is not the direct reason; depletion of prey base caused by disturbance and higher encounter rate with domestic livestock are possibly the reasons.

Key words: prey preference, *Panthera pardus fusca*, *Cuon alpinus*, *Hyaena hyaena*, conflict, thorn forest, southern India

INTRODUCTION

The Leopard *Panthera pardus fusca* is a large cat distributed throughout Peninsular India. According to Nowell and Jackson (1996) it is the most widely distributed of all the wild cats. It is found in almost every kind of habitat from rain forests of the tropics to deserts and temperate areas (Kitchener 1991). In Peninsular India, its principal habitat varies from tropical evergreen rain forest to open tropical dry thorn forest. It also lives outside forest areas (Prater 1971).

Leopards hunt by stalking, taking their prey opportunistically and mostly at night, especially where people have persecuted it (Nowell and Jackson 1996). The prey of Leopards varies in different geographical areas. In Kruger National Park, South Africa, Leopards were found to kill mainly medium-sized prey such as Impala (*Aepyceros melampus*), though a wide variety of small animals including hyraxes, civets and mongooses also formed part of their diet (Bailey 1993). In Tai National Park, Ivory Coast, leopards prey on about 30 species of animals (Hoppe-Dominik 1984). Small prey also constituted a significant proportion of Leopard diet in Tsavo, Kenya (Hamilton 1976). Bothman and Riche (1984) found that in the Kalahari Desert leopards fed on small prey like Bat-eared Fox (*Otocyon megalotis*), jackals (*Canis* spp.), genets (*Genetta* spp.), hares (*Lepus* spp.), duiker (*Cephalopus* spp.) and porcupine (*Hystrix* spp.). In the Serengeti, Tanzania, Bertram (1978) found 30 species in a sample of 150 Leopard kills. Muckenhirn and Eisenberg (1973) reported that in Sri Lanka leopards preyed mainly on Chital (*Axis axis*) and Indian Wild Boar (*Sus scrofa*), while also feeding on Sambar (*Cervus unicolor*), Common Langur (*Semnopithecus entellus*), Black-naped Hare (*Lepus nigricollis*), Indian Porcupine (*Hystrix indica*) and calves of domestic buffalo. In India, Schaller (1967), Johnsingh (1983), Karanth and Sunquist (1995, 2000) and Venkatraman *et al.* (1995) studied leopard food habits; the major prey reported were Chital, Sambar, Barking deer (*Muntiacus muntjak*), Goral (*Nemorhaedus* spp.) and livestock. According to Edgaonkar and Chellam (1998), the major prey of leopard was found to be domestic dog, domestic buffalos and rodents in Sanjay Gandhi National Park (SGNP), Maharashtra. In the Mundanthurai plateau of Tamil Nadu, Sathyakumar (1992) reported that leopards prey mainly on Sambar, Black-naped Hare, Chital and livestock. In Bandipur, Johnsingh (1983) found that 66% of Leopard kills were Chital. Chellam (1993) found that in Gir, 40% of Leopard scats were Chital and 25% Common Langur. In the tropical forest of Nagarhole, southern India, Karanth and Sunquist (1995) found that Chital constituted the major prey base of leopards.

Leopards have been found to coexist with other large carnivores across most of their range. In Asia, it shares its habitat with the Tiger and Dhole (Karanth and Sunquist 1995, 2000; Venkataraman *et al.* 1995). In Zaire, Central Africa, Hart *et al.* (1996) found the Leopard coexisting with the Golden Cat (*Felis aurata*) by specializing on different prey. In Nagarhole, southern India, Karanth and Sunquist (2000) found that the Tiger, Leopard and Dhole selectively killed different prey in terms of species, size and age-sex classes, allowing for the coexistence of all three predators.

In this paper we aim to study (i) the food habits of the Leopard in disturbed and undisturbed habitats, (ii) overlap of their diet with that of the Dhole (*Cuon alpinus*) and the Striped Hyena (*Hyaena hyaena*), (iii) assessment of habitat quality, wild prey abundance and human pressure near and away from the villages, and (iv) impact of leopards on domestic livestock. We use the results to suggest possible ways to minimise and mitigate human-leopard conflicts.

STUDY AREA

The study was carried out in the Sigur Reserve Forest (Nilgiris district) and part of Thalamalai Reserve forest (Erode district) (11° 30' 11° 35' N and 76° 45' 76° 52' E), Tamil Nadu state. The Sigur plateau abuts this area on the west. The study area acts as a corridor between the Western and Eastern Ghats. The perennial Moyar and Kukkalthorai Halla rivers drain the entire area, which receives rainfall mostly from the north-east monsoon between September and November. However, the annual rainfall is very low (400 mm) as the area falls in the rain shadow. The altitude is around 350 m above msl. Vegetation is tropical dry thorn forest (Champion and Seth 1968) dominated by *Strychnos potatorum*, *Canthium parviflorum*, *Zizyphus mauritiana*, *Azadirachta indica*, *Moringa concanensis*, *Hardwickia binata*, *Bridelia retusa* and *Diospyros montana*. The Moyar riverbeds in Mangalapatti Bhawanisagar and adjacent areas are dominated by an introduced species *Prosopis juliflora*.

The large mammal fauna in this area includes the Asian Elephant (*Elephas maximus*), Gaur (*Bos gaurus*), Sambar (*Cervus unicolor*), Chital (*Axis axis*), Blackbuck (*Antilope cervicapra*), Four-horned Antelope (*Tetracerus quadricornis*), Bonnet Macaque (*Macaca radiata*), Common Langur (*Semnopithecus entellus*), Indian Wild Boar (*Sus scrofa*) and Indian Porcupine (*Hystrix indica*). Mammalian predators include Leopard (*Panthera pardus*), Tiger (*Panthera tigris*), Asiatic Wild Dog (*Cuon alpinus*), Striped Hyena (*Hyaena hyaena*) and Jackal (*Canis aureus*). Other fauna of the study area include Black-naped Hare (*Lepus nigricollis*), Common Palm Civet (*Paradoxurus hermaphroditus*), Jungle Cat (*Felis chaus*), Indian Peafowl (*Pavo cristatus*), Grey Junglefowl (*Gallus sonneratii*), Python (*Python molurus*), Marsh Crocodile (*Crocodylus palustris*), Indian Star Tortoise (*Geochelone elegans*), Indian Black Turtle (*Melanochelys trijuga*), Leith's Softshell Turtle (*Aspideretes leithii*) and Monitor Lizard (*Varanus bengalensis*).

A large number of cattle are reared in the adjacent villages of Thengumarahada, Pudukadu, Hallimoyar and Kallampalayam. Cattle compete for food with natural prey of larger carnivores besides spreading diseases such as foot and mouth, rinderpest and anthrax to wild animals. Overgrazing by cattle is a serious problem in these villages. Firewood and timber collection by locals also contributes to the degradation of the forest.

METHODS

The study area was divided into 'Highly disturbed area' HDA (high prevalence of woodcutting and cattle grazing) and 'Less disturbed area' LDA (relatively little human disturbance). The HDA included 10 sq. km of dry thorn forest adjacent to the villages of Thengumarahada, Pudukadu and Hallimoyar. The less disturbed area covered an area of 10 sq. km, and was also dry thorn forest, but at least 10 km away from any village.

Leopards are known to be largely nocturnal and not easily seen (Bertram 1978). Direct observation of prey capture is not easy and hence most studies on leopard food habits rely on indirect evidence from kills and scats (Bertram 1978; Karanth and Sunquist 1995). In our study we use indirect evidence to understand the food habits of the Leopard, Dhole and Striped Hyena.

Scat analysis

Scats of leopards, dholes and striped hyenas were collected once a week each on Mangalapatti Road (12 km), Palamarapatti Road (12 km), Hallimoyar Road (8 km), and Bhawanisagar Road (8 km).

The scats were identified from their characteristic appearance and supplementary evidence in the form of tracks, scrapes and size of the scat (Karanth and Sunquist 1995). Scats were air-dried and kept in separate polythene bags.

For diet analysis, scats were soaked in water, washed, and strained thoroughly to separate prey remains like bones, hooves, hair, quills and feathers. Samples of hairs from the scats were washed in water, dried and passed through ether and xylene (Koppikar and Sabins 1975). They were then

mounted on a slide in liquid paraffin and examined under a binocular microscope (15x). At least twenty hairs were examined from each scat (Mukherjee *et al.* 1994). Prey species were identified using features such as colour, length, thickness and characteristic medullar configurations (Karanth 1993). Hair samples were also compared to reference slides prepared from hair of known species and collections of the Indian Institute of Science Research Station. Identification keys given by Koppikar and Sabins (1975), Oli (1993) and Easa (1995) were also used. Schaller's method (1967) was adopted to obtain the frequency and percentage of food items in scat (the annual prey requirement of the Leopard appears to be about 1,000 kg; based on this the frequency of food items in scats and their percentages were calculated). Jaws of ungulates were identified following Cohen's (1977) guidelines. Wilcoxon matched pairs test was done to look at the difference in highly disturbed and less disturbed areas within each species and also to compare dietary composition between pairs of species.

Kill data collection

An intensive search for kills over the entire study area was a daily routine. Clues like smell of carcass, alarm calls of Chital and Common Langur, predator signs and calls, and movement of vultures and crows aided in detecting kills. Whenever kills were found, the following information was recorded; identity of the predator by ancillary evidences such as tracks, scats, scrape marks, tooth marks, type of killing injury, feeding method and catching behaviour, the species killed, sex and approximate age of the individual; description of microhabitat.

Calculation of niche-breadth, niche-overlap and food preference indices

Niche breadth was estimated using formula described by (Hurlbert 1978): $Bi = 1/\Sigma Pi^2$

Bi = Levins' measure of niche breadth

where Pi is the proportion of individuals found in or using resource state 'i' or fraction of items in the diet. This measure was standardized to a scale of 0-1 by using the formula $B_A = (B-1)/(n-1)$

where B_A = Levins' standardised niche
B = Levins' resources of niche breadth
n = number of possible resource states

Niche-Overlap

The niche-overlap between leopards, dholes, and striped hyenas were calculated as described by Schoener (1970) using the following formula:

$$\text{Niche-overlap} = 1 - 1/2 \sum_{i=1}^{i=n} | P_{ij} - P_{ik} |$$

where 'P_{ij}' is the proportion of use of 'i' th resource by species 'j' and

'P_{ik}' is the proportion of use of 'i' th resource by species 'k'

Food Preference Index

Ivlev's (1961) index was used as an index of food preference:

Ivlev's index of selection = (U-A)/ (U+A)

where 'U' denotes percent use and 'A' denotes percent available and lies between +1 to -1.

Assessment of prey abundance

Prey abundance was estimated by two methods:

1. **Direct counts (encounter rates)**: Population of Chital, Blackbuck, and cattle were estimated based on direct counts. Known sites of prey aggregations were visited and animal numbers in each area were recorded. In addition to this, all wild prey and livestock encountered (encounter rate = number of animals sighted per km of trail walked) in the study area were recorded. The data so collected gave an approximate index of wild prey and livestock inhabiting the area. From these estimates, the prey biomass in the area was calculated by multiplying the number of animals of a species inhabiting the area with the average weight of the species. The direct count method is preferred to transect for the following reasons.

a. The prey species populations were very low (R. Arumugam pers. obs.) and the effort required would have been very high for species like Chital and Blackbuck.

b. Since the prey aggregate at known sites during the evening, direct counts should give a better estimate.

2. **Pellet counts**: Pellet count method was adopted to estimate the relative abundance of some of the more elusive, secretive and nocturnal animals (Indian Porcupine, Black-naped Hare and Sambar) which were not censused by the direct counts. This will give an indirect estimate of prey abundance. A grid was laid across the study area and random blocks were chosen for sampling. Fixed width transects (rectangular plots of 10 m x 2 m) were laid in these randomly chosen blocks and all the pellets (pellet groups) encountered in these strips counted. In all 66 plots were laid in the HDA and 59 plots in the LDA and the number of pellet groups of each species was recorded.

Assessment of Human disturbance

Tree density was estimated by counting all woody stems above 10 m x 2 m girth within the same plots that were used for estimating pellet abundance. Intensity of tree lopping

signs and cattle grazing signs were taken as a measure of the extent of human disturbance in an area. Lopping signs were also recorded in the same plots. Then the percentage of lopping was calculated as: $(n_l / N) \times 100$, where n_l = trees lopped, N = total trees

Similarly, cattle dung density per hectare (number of dung piles) was used to quantify the impact of livestock grazing in an area.

RESULTS

Extent of human disturbance in the two study sites

Strychnos potatorum, *Canthium parviflorum* and *Capparis zeylanica* were the major woody plant species in both the highly disturbed (HDA) and less disturbed (LDA) areas in the study sites. However, overall tree density was lower in the HDA (348.44/ha) than in the LDA (398.22/ha) (see appendix 1). Lopping signs were present on 9 plant species in the HDA and only on 2 species in the LDA (see appendix 1). *Strychnos potatorum* suffered the most in both areas, with all the trees of this species suffering damage in the HDA. The number of plants that suffered damage was 151.50/ha (43.48%) in the HDA and 76.16/ha (19.13%) in the LDA.

Scat Analysis

Leopard: Seventy-four leopard scats were analyzed, of which 45 were from the HDA and 29 from the LDA. Chital was the commonest prey in both as its remains constituted 35.3% of the scats in the highly disturbed, and 55.9% in the LDA (Table 1, Fig. 1). The Leopard's use of livestock was more in the highly disturbed (33.3%) than in the LDA (14.7%). Sambar was another common prey in both. Blackbuck remains were found only in the scats collected from the LDA. Wild boar and Indian Porcupine were a part of the diet only in the HDA.

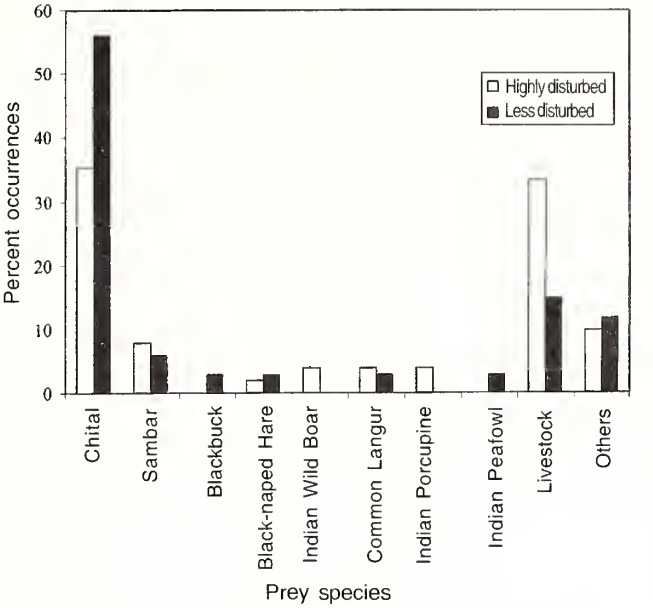

Fig. 1: Diet composition of Leopard in the highly disturbed and less disturbed areas

Table 1: Percent occurrence of different prey remains in Leopard, Dhole, and Striped Hyena scats in the highly disturbed and less disturbed areas during the study period

Species	% occurrence					
	Leopard (*Panthera pardus fusca*)		Dhole (*Cuon alpinus*)		Striped Hyena (*Hyaena hyaena*)	
	Highly Disturbed	Less Disturbed	Highly disturbed	Less Disturbed	Highly disturbed	Less disturbed
Chital	35.3	55.9	71.4	52.6	87.5	66.7
Sambar	7.8	5.9	4.8	0	0	0
Blackbuck	0	2.9	0	5.3	0	0
Black-naped Hare	1.9	2.9	14.3	26.3	0	11.1
Indian Wild Boar	3.9	0	0	5.3	0	0
Common Langur	3.9	2.9	0	0	0	0
Indian Porcupine	3.9	0	0	0	0	0
Indian Peafowl	0	2.9	0	0	0	0
Livestock	33.3	14.7	0	5.3	12.5	22.2
Others*	9.8	11.8	9.5	5.3	0	0

– Number of scats analysed in the highly disturbed and in the less disturbed area: Leopard 45 and 29, Dhole 21 and 16, and Hyena 8 and 9
– * Others' include reptilian scales and unidentified remains.

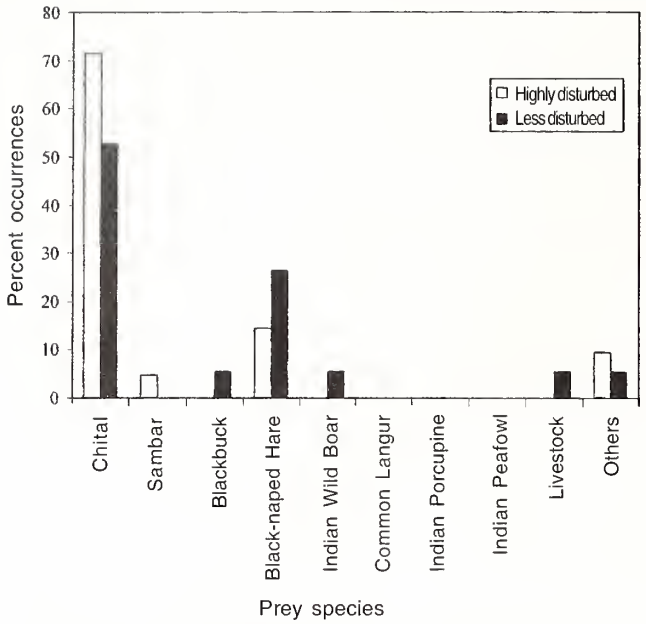

Fig. 2: Diet composition of Dhole in the highly disturbed and less disturbed areas

Leopards in both areas (Table 1) preyed on Black-naped Hare and Common Langur.

Percent occurrences of prey items in the Leopard's scat are given in Table 1. Wild prey constituted a major portion of Leopard diet in the less disturbed (88.4%) while livestock formed a significant portion (33.3%) in the HDA (Table 1).

The estimated biomass of different prey species taken by leopards are given in Table 2. In the HDA the biomass of livestock consumed (2,664 kg) exceeded all other prey species collectively (2,394 kg). On the other hand, leopards depended more on its natural wild prey in the LDA, with Chital forming the bulk (2,683.2 kg). Cattle biomass consumed by leopards in the LDA was 1,176 kg, under half that in the highly disturbed.

Dhole: Twenty-one scats from the highly disturbed and 16 scats from the LDA were analyzed. Chital was the major prey species in both areas and their remains were found in 71% of scats in the highly disturbed and 52.6% of scats in the LDA (Table 1, Fig. 2). Other prey items were Sambar and Black-naped Hare in the highly disturbed and Blackbuck, Black-naped Hare, and Indian Wild Boar in the LDA. One scat from the LDA had remains of livestock.

Striped Hyena: Seventeen scats, eight from the highly disturbed and nine from the LDA were analyzed. Only Chital (88%) and livestock (13%) remains were found in the scats from the HDA (Table 1, Fig. 3). In the LDA, Striped Hyena scats had remains of Chital (67%), Black-naped Hare (11%), and livestock (22%).

Prey abundance

Abundance and biomass availability of Chital and livestock were analysed. The LDA had a higher density and biomass of Chital than the HDA (12.1 animal/sq. km and 555 kg/sq. km vs 4.1 animal/sq. km and 185 kg/sq. km, respectively). On the other hand, livestock density and biomass were greater in the highly disturbed than the LDA (53.3 animal/sq. km and 1700 kg/ha vs 1.0 animal/sq. km and 200 kg/sq. km respectively). Relative abundance of other prey species in the highly disturbed and LDAs was assessed by the pellet densities (Table 3 & 4). Chital, Sambar and Blackbuck (the natural prey of leopard) were more abundant in the LDA while livestock relative density was greater in the HDA.

Table 2: Estimates of relative biomass of prey taken by leopards in the study area

Prey Species	Estimated (average) Live Weight [a]	Percent occurrence of prey remain in scats		Relative biomass [b] (kg)	
		Highly disturbed area	Less disturbed area	Highly disturbed area	Less disturbed area
Chital	48	35.3	55.9	1,694.4	2,683.2
Sambar	62	7.8	5.9	483.6	365.8
Blackbuck	48	0	2.9	0	139.2
Black-naped Hare	3	1.9	2.9	5.7	5.7
Indian Wild Boar	38	3.9	0	148.2	0
Common Langur	8	3.9	2.9	31.2	23.2
Indian Porcupine	8	3.9	0	31.2	0
Livestock	80	33.3	14.7	2,664	1,176

a- Approximate weights of prey species from Karanth and Sunquist (1995) except for livestock, for which an assumed weight of 80 kg was used; for blackbuck the average weight of 48 kg is assumed based on a similar species, the Chital.
b- Relative Biomass = Average weight x Relative frequency.

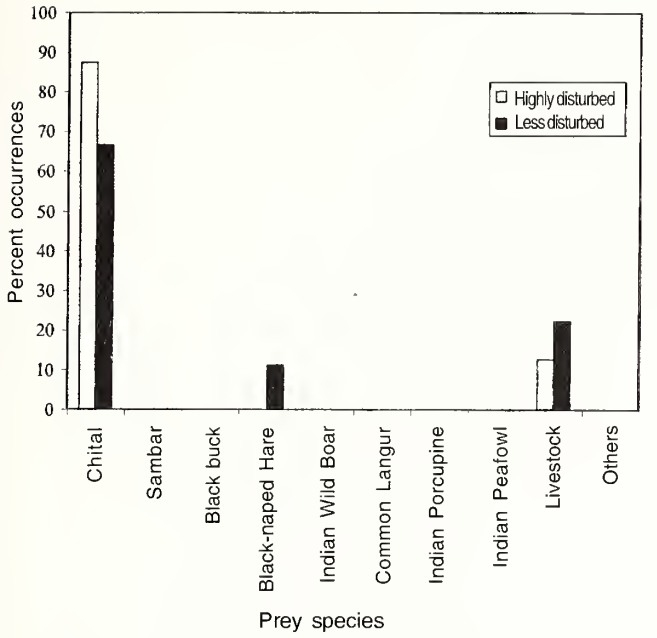

Fig. 3: Diet composition of Striped Hyena in the highly disturbed and less disturbed areas

There is no difference in the dietary composition in HDAs and LDAs of Leopard, Dhole and Striped Hyena using Wilcoxon Matched Pairs test with $p > 0.05$. There is also no difference in relative prey abundance between HDAs and LDAs using Wilcoxon Matched Pairs test ($p=1.0$). However, when the relative availability of prey and the relative proportion of prey eaten were compared using chi-square test, there was significant difference for all species (leopards $\chi^2 = 303.31$, $df = 6$, $p < 0.001$, dholes $\chi^2 = 311.32$, $df = 6$, $p < 0.001$ and striped hyenas $\chi^2 = 112.76$, $df = 6$, $p < 0.001$).

Table 3: Comparison of prey species abundance in the highly disturbed and less disturbed area of the study region during the study period (Based on pellet counts)

Prey Species	Relative Density (%)	
	Highly Disturbed area	Less Disturbed area
Chital	14.0	24.0
Sambar	7.5	12.1
Blackbuck	4.3	28.5
Black-naped Hare	27.6	21.5
Indian Wild Boar	2.5	2.4
Indian Porcupine	2.5	1.6
Livestock	41.6	9.9

Niche breadth

Leopards had a wider niche breadth in the HDA (0.323) than in the LDA (0.202), but dholes and striped hyenas had a wider niche breadth values in the LDA (Table 5).

Niche-overlap

Food niche-overlaps between the three predator species as derived from the data from scat analyses are given in Table 6. Leopards had a higher overlap with both dholes and striped hyenas in the LDA than in the HDA. The overlap between dholes and striped hyenas was higher in the HDA. In most cases, overlap values were higher than 0.5, indicating a high degree of similarity in food habits among the predators.

Prey preference

Prey preference values are shown in Table 7. Results showed that the Leopard had a positive preference for Chital in both areas with the values of +0.49 and +0.48 in highly disturbed and LDAs, respectively. A negative preference for Black-naped Hare was shown in both areas, while there was a positive preference for Sambar (+0.10) in the HDA and negative preference in the LDA (-0.25). Blackbuck remains were found in the scats of LDA only; the species had a negative

Table 4: Relative abundance of prey species and their proportions in the diet of predators

Prey species	Available prey (Expected)	Proportion of Leopard diet	Proportion of Dhole diet	Proportion of Striped Hyena diet
Chital	19	54.4	67.3	77.1
Sambar	9.8	8.1	2.6	0.0
Blackbuck	16.4	1.8	2.8	0.0
Black-naped Hare	24.5	2.9	21.8	5.6
Indian Wild Boar	2.5	2.3	2.8	0.0
Indian Porcupine	2.0	2.3	0.0	0.0
Livestock	25.8	28.2	2.8	17.4

Chi-square tests for abundance of prey species and their proportion in the diet of predator.
(Leopard – $\chi^2 = 303.31$, $df = 6$, $p < 0.001$,
Dhole – $\chi^2 = 311.32$, $df = 6$, $p < 0.001$,
Striped Hyena – $\chi^2 = 112.76$, $df = 6$, $p < 0.001$)

Table 5: Food niche - breadth values for Leopard, Dhole and Striped Hyena during the study period

Part of the study area	Predator Species		
	Leopard	Dhole	Striped Hyena
Highly disturbed area	0.323	0.094	0.031
Less disturbed area	0.202	0.202	0.107

Table 6: Food niche - overlaps among the three predator species during the study period

Part of the study area	Niche-Overlap values		
	Leopard and Dhole	Dhole and Striped Hyena	Leopard and Striped Hyena
Highly disturbed area	0.516	0.714	0.479
Less disturbed area	0.690	0.684	0.706

preference value of -0.78. Wild Boar and Indian Porcupine remains were recorded from Leopard scats in HDA only and their preference indices were +0.29. Livestock preference values were -0.04 in the HDA and -0.29 in the LDA. Chi-square tests showed that leopard prey preferences were significantly different in both habitats. ($\chi^2 = 159.34$, df = 9 and $p < 0.0$, for disturbed area; $\chi^2 = 255.06$, df = 9 and $p < 0.0$, for LDA)

Prey preference values for Dhole are given in Table 7. Chital had a positive prey-preference index in both areas. Even though Sambar and Black-naped Hare were fed on by dholes in the HDA, they had negative preference values of -0.17 and -0.35, respectively, in the HDAs. Blackbuck and cattle had negative preference values in the LDA, whereas Black-naped Hare and Indian Wild Boar had positive preference values.

For Striped Hyena, the prey preference index values were positive for Chital in both areas (Table 7). Livestock had a negative preference of -0.54 in the HDA and a positive preference of +0.38 in the LDA. Black-naped Hare remains were found only in the scats of the HDA with a negative preference (-0.32). Differences in prey preference were significant ($\chi^2 = 441.57$, df = 9 and P=<0.0, for HDA; $\chi^2 = 256.88$, df = 9 and P=<0.0, for LDA).

Kill data

In all, 30 leopard kills were recorded during the study period. Six human deaths and injuries to two had been recorded during 1992-1997 in the study area. Of the leopard kills, 20 were cattle, 9 were Chital and one was a Sambar. On four occasions, cattle escaped with injuries from leopards. In most cases, the prey was found eaten almost completely with only a few bones left. Most of the kills were found in the open dry thorn forest area. Of the 20 cattle killed, four each were adult males, subadult males and adult females; six were subadult females and two were calves. Among the nine Chital killed, three each were adult males, adult females and fawns. The two Sambar kills recorded were both sub adults. On a few occasions, the local people collected the skin and meat, especially when the kill was that of a Chital or Sambar. Once a crocodile was seen eating a cattle carcass killed by Leopard.

DISCUSSION

Prey selection by leopards

The major wild prey of Leopards in the study area was Chital, which constituted 35.3% and 55.9% of the diet in the highly disturbed and LDAs, respectively. This might be due to higher Chital population in the study area compared with other natural prey like Sambar. On the other hand, Sathyakumar (1988) found Sambar to be the preferred prey in the Mundanthurai plateau and attributed this to the fact that Leopard and Sambar are nocturnal animals and the Leopard, as a stalker, could easily stalk and kill Sambar. In both studies, as in Africa (Bailey 1993), ungulates constituted a major portion of the diet.

Schaller (1972) found the Leopard was mainly preying on animals in the 20-70 kg class. In our study also, smaller prey constituted a lower proportion of the Leopard's diet. However, Seidensticker *et al.* (1990), found that 36% of the Leopard's prey in Chitwan was under 25 kg. Leopards are highly adaptable animals that can co-exist with the tiger because their diet includes a variety of smaller animals that are usually ignored by tigers (Sankhala 1977).

Table 7: Prey preference indices for leopard, dhole and striped hyena in the highly disturbed and less disturbed area of the study region during the study period

Prey species	Leopard		Dhole		Striped Hyena	
	Highly Disturbed area	Less Disturbed area	Highly Disturbed area	Less Disturbed area	Highly Disturbed area	Less Disturbed area
Chital	+0.49	+0.48	+0.70	+0.40	+0.72	-0.54
Sambar	+0.10	-0.25	-0.17	0	0	+0.47
Blackbuck	0	-0.78	0	-0.67	0	0
Black-naped Hare	-0.85	-0.72	-0.35	+0.13	0	0
Wild Boar	+0.29	0	0	+0.40	0	-0.32
Indian Porcupine	+0.29	0	0	0	0	0
Livestock	-0.04	+0.29	0	-0.28	-0.54	+0.38

Black-naped Hare remains were found in the scats of Leopards both in the highly disturbed and LDA, in both of which Black-naped Hare pellets were quite abundant. Chellam (1993) did not find Black-naped Hare to be a preferred food item in the Mundanthurai plateau, while Karanth and Sunquist (1995) estimated that about 5% of prey in Nagarhole comprised Black-naped Hare, Sathyakumar (1988) stated that the presence of Black-naped Hare remains in the Leopards' diet might be because it could be easily hunted.

Arboreal prey (Indian Peafowl and Common Langur) comprised 3.9% in the HDA and 5.8% in the LDA. According to Sankhala (1977), the ability of the Leopard to climb trees with ease provides access to prey like arboreal animals like squirrels, langurs and other monkeys. Karanth and Sunquist (1995) also attributed the comparatively high degree of predation on Common Langur by Leopard at Nagarhole to the Leopard's greater arboreal habits and cryptic nature in comparison to the tiger. Another possible interpretation is that Leopards kill primates when they descend from trees (Singh 1985). Sathyakumar (1988) also observed Nilgiri Langur (*Presbytis johni*) and Bonnet Macaque (*Macaca radiata*) in the food of leopards in the Mundanthurai plateau, but Seidensticker (1983) stated that when the prey base was abundant the leopard would take the primates only occasionally. On the other hand, Schaller (1967) found leopards to be killing Common Langur frequently in Kanha Tiger Reserve, in Madhya Pradesh. Many other studies have documented the opportunistic nature of the Leopard's hunting pattern (Bothman and Le Riche 1984; Eisenberg 1986; Bailey 1993).

Remains of Indian Wild Boar were found only in 2 scats (4.4%) in the HDA. Similar findings were reported for the leopards of Mundanthurai plateau by Sathyakumar (1988). Killing Indian Wild Boars is not easy for leopards as they are formidable adversaries (Sankhala 1977; Karanth and Sunquist 1995).

Livestock were an important component in both the highly disturbed (33.3%) and less disturbed (14.7%) parts of the study area. Many livestock kills were recorded in the surrounding villages, and Sathyakumar (1988) also reported cattle kills in the Mundanthurai plateau. Seidensticker *et al.* (1990) found livestock to be a major component of the Leopard's diet at the fringes of the Royal Chitwan National Park, where the densities of domestic ungulates were higher than those of wild ungulates inside. Edgaonkar and Chellam (1998) were found domestic dogs, domestic buffalos and rodents are the major prey for leopard in SGNP. According to Singh (1986), an increased trend of cattle killing behaviour suggests highly disturbed behaviour.

Niche-overlaps with other predators

There was substantial dietary overlap between the Leopard, Dhole and Striped Hyena, with values from 0.516-0.690 between Leopard and Dhole, 0.479-0.706 between Leopard and Striped Hyena and 0.684-0.714 between Dhole and Striped Hyena. Colwell and Futuyma (1971) define niche overlap as joint use of a resource by two or more species. Hutchinson (1958) describes it as the area of space shared by two or more continuous niches. A substantial overlap between the diets of leopard and dhole in the Mundanthurai plateau was reported by Sathyakumar (1988) and by Karanth and Sunquist (1995) in Nagarhole. The results are consistent with the hypothesis of Bekoff *et al.* (1984) that larger predators take more prey types, since leopards took at least nine prey types, dholes 6 prey types and hyenas three prey types in the study area.

Dietary Preference

The present study showed that Chital was the preferred prey species for all the three predators studied, but overall prey preferences differed among them. A difference in the selectivity of prey species between leopards and dholes has been documented (Sathyakumar 1988; Karanth and Sunquist 1995). Livestock was selected by leopards according to availability, suggesting chance encounters were by primarily due to cattle grazing inside the natural habitats. Leopards did not seem to target cattle intentionally.

Though we identified hair from the scats to species level, we are not able to quantify the numbers of individuals, which could vary amongst predators. Therefore, these predators may not be competing with each other as much as the data from scats appears to show.

Human-leopard conflicts

Twenty cattle kills in five months, and eight human attacks in 1992-1997, of which six were fatal, were recorded in the study area. The problem clearly needs immediate attention. As Sawarkar (1989) pointed out, when large cats live in proximity to humans, some amount of conflict at the interface is inevitable. But the extent of cattle killing in the study area is very high and seemed to be the outcome of human interference in the natural habitat of Leopards, since more casualties were in the HDAs where large scale habitat destruction had taken place.

Man-eating by Leopards was another disturbing factor. Schaller (1967) mentioned that Leopards may eat humans occasionally. As Daniel (1996) mentions, when a Leopard becomes a man-eater it could be more dangerous than a Tiger because of its boldness and cunningness in entering villages. Corbett (1981) reports that leopards turn to human prey under

special circumstances. For instance when an epidemic killed a large number of people in the Himalaya, the bodies were not cremated but simply pushed down into the valleys and the leopards scavenging on the corpses acquired a taste for human flesh. According to Sunquist and Sunquist (1989), small island-like reserves of ideal habitat may be sources for man-eaters, with dispersing young adults being pushed out of prime habitat taking to man-eating in human habitation. Saberwal *et al.* (1994) also found it was sub-adult lions which were disproportionately involved in conflict situations in Gir and attributed this to the high density of lions in the park and poorer habitat quality at the fringes. The cattle-lifting and man-eating by leopards observed in the present study were mainly due to poor habitat quality and human intrusion into their natural habitats for wood cutting and cattle grazing. To overcome the problem the following management recommendations are suggested.

Because cattle compete for food with natural prey species such as Chital, Sambar, Blackbuck and Black-naped Hare, cattle populations should be reduced in villages near Leopard habitats. Since, man-eating and cattle-lifting traits in leopards may be transmitted from generation to generation, an individual Leopard that frequently kills cattle and human beings should be trapped and removed as soon as possible.

Leopards need a certain amount of vegetational cover to hunt wild prey, therefore wood collection in forest areas should be minimised. Local people use domestic dogs to kill wild herbivores such as Chital, Sambar and Black-naped Hare, which not only reduces wild prey density near villages but also drives the remaining wild prey to the interior of the forest. Hunting of wild animals should, therefore, be severely punished. Local people should be made to understand that poisoning is not a solution for the problem, since when a leopard is removed from its natural habitat another will soon occupy its territory.

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APPENDIX 1

Vegetation density and percentage of lopping signs in the highly disturbed and less disturbed regions of the study area

S. No.	Plant Species	Density (no./ha)		Lopping signs (% tree sampled)	
		Highly disturbed	Less disturbed	Highly disturbed	Less disturbed
1	*Strychnos potatorum* (Tree)	68.18	118.64	100.0	57.47
2	*Canthium parviflorum* (Shrub)	68.18	67.79	22.22	12.49
3	*Acacia arabica* (Tree)	30.30	25.42	50.0	0.00
4	*Acacia pennata* (Tree)	15.15	16.94	41.9	0.00
5	*Azadirachta indica* (Tree)	15.15	33.89	0.00	0.00
6	*Capparis zeylanica* (Shrub)	22.72	33.89	33.4	0.00
7	*Diospyros montana* (Tree)	15.15	8.47	0.00	0.00
8	*Ziziphus mauritiana* (Tree)	15.15	8.47	41.9	0.00
9	*Xeromphis spinosa* (Tree)	7.57	16.94	0.00	0.00
10	*Sapindus emarginata* (Tree)	7.57	33.89	0.00	0.00
11	*Bridelia retusa* (Tree)	15.15	0.00	0.00	0.00
12	*Ficus glomerata* (Tree)	15.15	0.00	100.0	0.00
13	*Grewia* spp. (Tree)	7.57	0.00	100.0	0.00
14	*Fluggea leucopyrus* (Shrub)	15.15	0.00	0.00	0.00
15	*Moringa concanesis* (Tree)	30.30	0.00	0.00	0.00
16	*Gardenia targida* (Tree)	0.00	16.94	0.00	0.00
17	*Chloroxylon swietenia* (Tree)	0.00	8.47	0.00	0.00
18	*Hardwickia binata* (Tree)	0.00	8.47	0.00	0.00

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NEW DESCRIPTIONS

A NEW SPECIES OF *VACCINIUM* L. (ERICACEAE) FROM INDIA[1]

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Vaccinium myodianum Panda & Sanjappa (Ericaceae) is described as new from Dibang Valley district of Arunachal Pradesh in India. The new species is also provided with illustration and probable affinities of its close allies.

Key words: *Vaccinium myodianum* sp. nov., Ericaceae, Dibang Valley district, Arunachal Pradesh

INTRODUCTION

The genus *Vaccinium* L. consists of about 450 species (Mabberley 1997), distributed in tropical Asia, Europe, south-eastern Africa, Madagascar and America. Of these, about 28 species are reported to occur in India (Panda 2006), distributed in the eastern Himalaya, north-eastern India (except Tripura) and hill tops of south-western Ghats.

Sleumer (1941) reported 33 sections in the genus, of which the Indian taxa represent six sections, namely *Galeopetalum* (J.J. Sm.) Sleumer, *Cyanophthalmos* Sleumer, *Vitis-idaea* (Moench) W.D.J. Koch, *Bracteata* Nakai, *Epigynium* (Klotzsch) Hook. *f.* and *Eococcus* Sleumer. Airy Shaw (1948) included a seventh section, *Aethopus* Airy Shaw. The new species described below clearly falls in the section *Epigynium* (Klotzsch) Hook. *f.*, mainly on account of the lenticillate stem and branches beset with lanceolate scales up to 5 mm long, lanceolate to oblong-lanceolate glabrous leaves, perulate racemes and spurless anthers.

As a result of revisionary work on the Family Ericaceae in India under 'Flora of India Project', several field trips to the eastern Himalaya and north-eastern India and herbarium visits to several Indian herbaria were made. During a herbarium visit to Arunachal Field Station (ARUN) under the Botanical Survey of India, Itanagar, Arunachal Pradesh (December 2002), an interesting specimen of a species of *Vaccinium* L. was consulted. A critical study of this specimen revealed that it is new to science and is described and illustrated here.

Vaccinium myodianum Panda & Sanjappa, sp. nov.
Fig. 1

Species nova *Vaccinium venosum* Wight valde affinis, sed foliis lanceolatis vel oblong-lanceolatis, rhachidibus 25-35 mm longis, bracteis majoribus (*c.* 6 x 3 mm), lobis calycis acuminatis et antherae thecis glabris differt, *et* a *V. subdissitifolium* P.F. Stevens differt ramulis glabris, foliis lanceolatis vel oblong-lanceolatis, basi anguste cuneatis, non rotundatis, lobis calycis acuminatis, corollis intus densissime pilosis *et* antherae thecis glabris.

Typus: INDIA: Arunachal Pradesh, Dibang Valley district, 10 km from Tewarygram, near Myodia, 2.ii.1988, S.K. Das 2985 (holotype: ARUN!).

Stout, erect shrub to treelet, up to 9 m high. Stem terete, profusely branched, lenticillate, glabrous, often covered with lanceolate scales up to 5 mm long; branches and twigs terete, glabrous. Leaves alternate, chartaceo-coriaceous, lamina lanceolate to oblong-lanceolate, 70-120 x 12-23 mm, serrate at margin, narrowly cuneate at base, acuminate at apex, glabrous; venation brochidodromous with 8-10 pairs lateral nerves, obscure above, conspicuous beneath; petioles 1-2 mm long, glabrous. Racemes axillary or pseudoterminal, perulate; rachis 25-35 mm long, 20-24-flowered, glabrous. Flowers 7-9 mm long; pedicels 3-4 mm long, glabrous; bract 1, basal, broadly ovate, *c.* 6 x 3 mm, ciliate at margin, shortly acuminate at apex, glabrous; bracteoles 2, opposite, basal, ovate-elliptic, *c.* 2 x 1 mm, ciliate at margin toward upper half, long acuminate at apex, glabrous. Calyx lobes broadly ovate, *c.* 1 x 0.5 mm, entire at margin, acuminate at apex, glabrous. Corolla urceolate, *c.* 4 x 2 mm, glabrous outside, densely pilose inside, lobes ovate, minute. Stamens 10, *c.* 4 mm long; filaments *c.* 1 mm long, slender, glabrous, dilated at base; anther lobes *c.* 1 mm long, glabrous except spinuous margin, each lobe with *c.* 2 mm long single tubule. Pistil *c.* 6.5 mm long; ovary subglobose, *c.* 2 x 1.5 mm, glabrous, ovules 6-8 on axile placenta in each locule; disc obscure; style *c.* 4.5 mm long, slender, glabrous. Fruits not seen.

Distribution: INDIA: eastern Himalaya (Arunachal Pradesh).

Flowering: February.

Etymology: This species is named after its type locality.

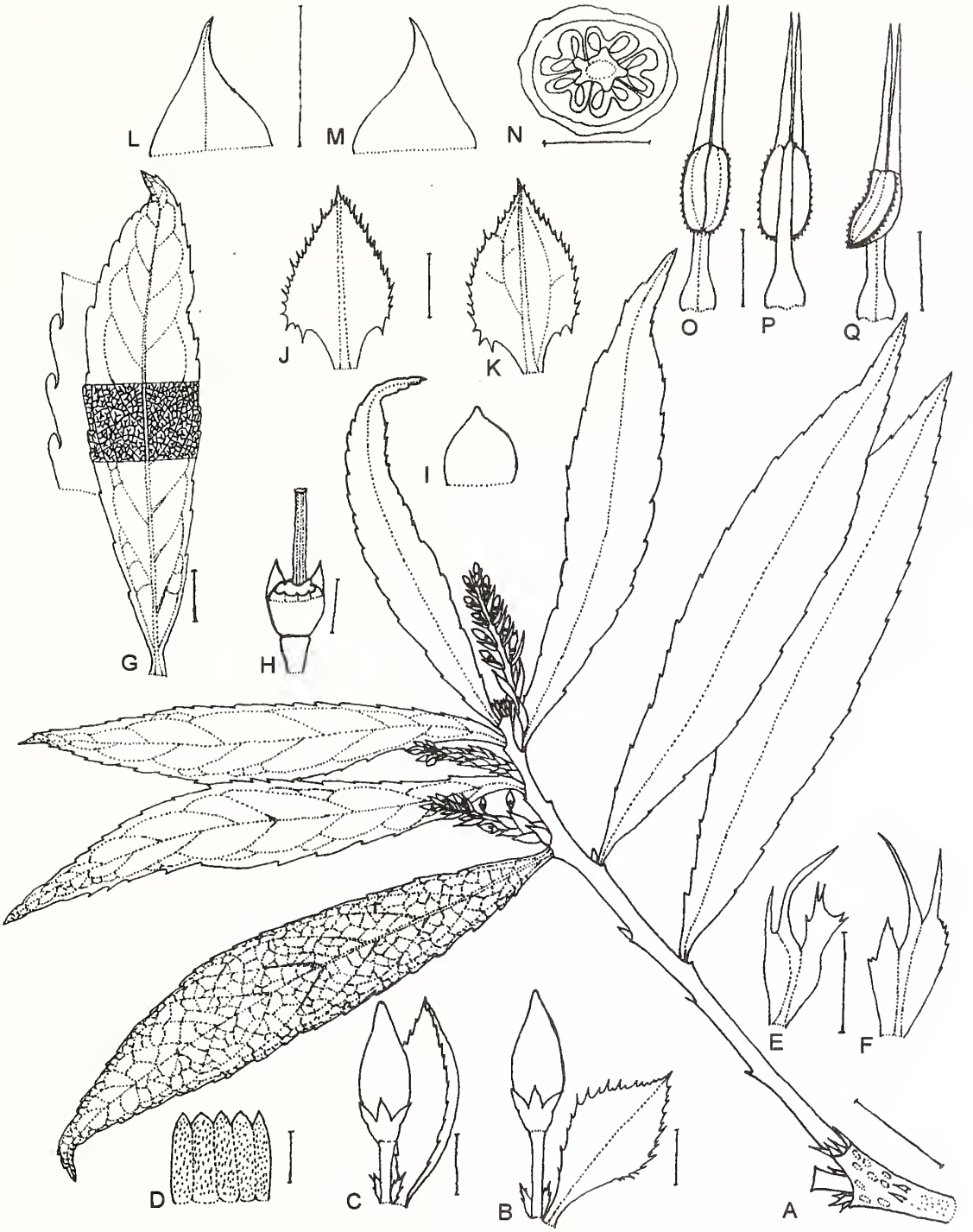

Fig. 1: *Vaccinium myodianum* Panda & Sanjappa, sp. nov.
A. Habit; B - C. Flower buds; D. Corolla split open; E - F. Bracteoles; G. Abaxial leaf; H. Pistil;
I. Corolla lobe; J - K. Bracts; L - M. Calyx lobes; N. Ovary (t.s.); O - Q. Stamens.
Scale bars: A = 2 cm; B - D, H = 2 mm; E - F, J - Q = 1 mm; G = 1 cm (A - Q: drawn from S.K. Das 2985)

DISCUSSION

Vaccinium myodianum is closely related to *V. venosum* Wight, a Sino-Himalayan species, from which it differs in having lanceolate or oblong-lanceolate leaf blades, short racemes (25-35 mm long), larger bract (*c.* 6 x 3 mm), acuminate calyx lobes and glabrous anther lobes. By contrast, *V. venosum* showed elliptic-oblong leaf blades, comparatively longer racemes (65-75 mm long), smaller bract (*c.* 2 x 1 mm), acute calyx lobes and granular anther lobes. *V. myodianum*

is also allied to another Sino-Himalayan species, *V. subdissitifolium* P.F. Stevens, but differs from it in having glabrous branches, lanceolate or oblong-lanceolate leaf blades, narrowly cuneate leaf-base, acuminate calyx lobes, densely pilose corolla inside and glabrous anthers. By contrast, *V. subdissitifolium* showed usually densely setose branches, oblong, obovate to ovate leaf blades, broadly to narrowly rounded leaf-base, acute calyx lobes, glabrous corolla and granular anthers.

ACKNOWLEDGEMENT

S. Panda is thankful to the Director, Botanical Survey of India for awarding the research fellowship.

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A NEW BUTTERFLY SPECIES OF THE GENUS *YPTHIMA* HUBNER (NYMPHALIDAE: SATYRINAE) FROM GARHWAL HIMALAYA, INDIA[1]

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The *sakra* species group under the genus *Ypthima* Hubner is represented by two species, *Y. sakra* and *Y. nikaea*, in the western Himalaya. During a survey of the Kedarnath Musk Deer Reserve (KMDR), Uttarakhand, India, a new species, *Y. kedarnathensis* sp. nov. belonging to this group was discovered, which is described in this paper.

Key words: *Ypthima sakra*, *Y. nikaea*, *Y. kedarnathensis* sp. nov., wing pattern, ocelli

INTRODUCTION

The Himalayan Five Ring *Ypthima nikaea* Moore (1874) is a species known from western Himalaya and Nepal with both the sexes having similar wing pattern (D'Abrera 1985; Smith 1989; Haribal 1992). Previously, *Y. nikaea* was treated as one of the three subspecies of *Y. sakra* found in India. The other two subspecies are *Y.s. sakra* Moore, which is more common in eastern Himalaya than in the western Himalaya, where its distribution extends up to Kullu in Himachal Pradesh, and *Y.s. ansteni* Moore, which is restricted to north-east India (Assam) and Burma (now Myanmar) (Evans 1932; D'Abrera 1985).

During field surveys (2006-2007) of butterflies in the south-eastern part of Kedarnath Musk Deer Reserve (KMDR), in the Garhwal Himalaya, Uttarakhand, India, 18 specimens of the sub-group *nikaea* were collected and two live specimens examined around the Mandal village (30° 27'-30° 28' N and 79° 15'-79° 16' E lying 10 km west from Gopeshwar town of Chamoli district). Out of these, five specimens (three collected and two live individuals examined were from two different locations 10 km apart), revealed uniform variation in wing pattern with respect to *Y. nikaea* and are described as a new species, *Ypthima kedarnathensis* sp. nov. The remaining fourteen specimens belonged to *Y. nikaea* and were distinct from the new species. *Y. sakra* was not represented in the collections from this area. The new species is described here based on wing pattern and its distinguishing features.

Systematic Account

Genus: *Ypthima* Hubner

Common name: The Rings

Ypthima Hubner1818, Zutr.z.samml.exot.Schmett, 1;17.

Diagnostic characters for genus *Ypthima*

Small sized butterflies with ocelli on fore and hind wings. Forewing has a large prominent two-pupilled ocellus located just below the apex in space 5 and at least an ocellus in space 2 on the upper hind wing (Fig. 1). Hind wing has varying number of rings on the outer discal area, which form the basis for identification of this genus. They also have striations and band on the underside of the wings. Some have seasonal forms; in dry season forms the ocelli are reduced to spots (Wynter-Blyth 1957; Haribal 1992). Forewing lower discocellular vein (between the origins of v6 and v4) (Fig. 1) is straight or concave; v10 always arising from v7 (Fig. 1) (Evans 1932).

Description

***Ypthima kedarnathensis* sp. nov.**

Wing pattern (male; wsf)

Wing span: 44-45 mm.

Upper side: Dark brown with thorax dorsally studded with reddish hairs which extend to basal area of forewing;

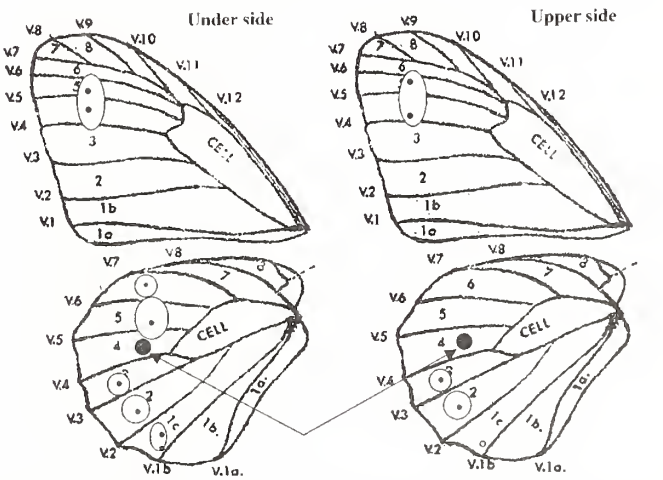

Fig. 1: Wing pattern of wet season form of *Ypthima kedarnathensis* sp. nov., (Holotype) showing the position of ocelli on the wings. The arrow depicts the position of an additional apical ocelli in this species in relation to *Y. nikaea*, which is visible on both upper and under sides of the hind wing between veins 4 and veins 5 in this species

Table 1: Distinguishing features in wing pattern between *Ypthima sakra, Y. nikaea and Y. kedarnathensis* sp. nov.

Sl. No.	Character	*Y. sakra*	*Y. nikaea*	*Y. kedarnathensis* sp. nov.
A.	Wing span	48-55 mm	45-52 mm	44-45 mm
B.	Upper side			
1.	Wing colour	Umber brown, terminal margins of the wing darker	Dark brown	Dark brown
2.	Forewing	Sub-apical ocellus large, oval bi-pupilled very slightly oblique	Sub-apical ocellus smaller than in *Y. sakra*, oval bi-pupilled	Sub-apical ocellus smaller than in *Y. sakra*, oval bi-pulled
3.	Hindwing	Four similar unipupilled round ocelli present, the pre-apical and tornal ocelli are frequently absent or faintly marked, the last when present always minute. [The pre-apical ocellus when present is on space 5 (between v5 and v6)].	Two sub-anal ocelli (male sometimes has one). The pre-apical and tornal ocelli are frequently absent or faintly marked, the last when present always minute. The pre-apical ocellus when present is on space 5 (between v5 and v6)	Four similar unipupilled round ocelli present. The pre-apical ocellus is faintly or sharply marked but always present on space 4 (between v4 and v5). The tornal ocelli are frequently absent or faintly marked, when present is always minute
C.	Underside			
1.	Wing colour and pattern	Under side yellow to ochraceous brown, thickly irrorated by transverse, short dark brown strigae	Grey with numerous short brown strigae	Yellowish with numerous short brown strigae
2.	Forewing	The encircling yellow ring of the pre-apical ocellus is broader. Sometimes a second very much smaller, obscure median ocellus is present	The encircling yellow ring of the pre-apical ocellus is sharply defined	The encircling yellow ring of the pre-apical ocellus is sharply defined.
3.	Hindwing	5 ocelli; 2 pre-apical ocelli large, geminate, encircled in a common yellow ring (do not have an intervening yellow band between them). The posterior 3 ocelli are in echelon with the 2 apical ocelli, with distinct ridges, the tornal ocellus bi-pupilled	5 ocelli; 2 apical ocelli large and have an intervening yellow band between them. The posterior 3 ocelli are arranged in a linear series from anal angle, the tornal ocellus bi-pupilled	5+1 = 6 ocelli; 3 apical ocelli present and their pupils form a 135 degree angle directed towards the 'apex'; all the three apical ocelli have an intervening yellow band between them. None of the 3 apical ocellus is larger than the other three posterior ocelli. However, the middle apical ocellus is larger than the other two apical ocelli (which are reduced) and is as big as the middle ocellus of the three posterior ocelli. The 3 posterior ocelli are arranged in a linear series from anal angle, the tornal ocellus is bi-pupilled

pupils of ocelli silvery blue. Forewing with an oval sub-apical bi-pupilled black ocellus which is yellow ringed with sharply defined edges.

Hind wing is with two prominent ocelli in space 2 and 3 between v2 and v4 and an additional very minute and faintly marked third ocellus in 1c (Fig. 1). An additional fourth sub-apical ocellus is present in space 4 between v4 and v5 (Fig. 1), and is visible also on the lowerside of hind wing at the same location.

Under side: Bright yellow with numerous short brown narrow strigae (quite similar to *Y. nikaea*). Forewing has an oval sub-apical bi-pupilled black ocelli, same in size as in *Y. nikaea* and smaller than in *Y. sakra*. Hind wing with 6 prominent ocelli. Location and size of 5th ocelli is similar to those in *Y. nikaea*, but differs in the presence of an additional small ocelli attached below the double apical ocelli [in space 4 between v4 and v5 (Fig. 1)]. All the three apical ocelli are connected together but have an intervening yellow band which is a common characteristic of *Y. nikaea*. The pupils of all the 3 apical ocelli form a 135 degree angle directed towards the 'apex'. The other three posterior ocelli are in a linear series from anal angle, the tornal/anal one being bi-pupilled.

The differences between the wing pattern of *Y. kedarnathensis* sp. nov., *Y. nikaea* and *Y. sakra* are given in Fig. 2 and discussed in Table 1. The wing pattern of *Y. sakra* and *Y. nikaea* described here are based on published literature (Moore 1874, 1893-1896; Marshall and deNiceville 1882; Bingham 1905; Evans 1932; Wynter-Blyth 1957; D'Abrera 1985; Smith 1989 and Haribal 1992).

MATERIAL EXAMINED

Holotype: Male, INDIA: Uttarakhand, KMDR, Mandal, 1,700 m above msl, 25.vii.2006. Coll. Arun P. Singh, Type material in 'National Forest Insect Collection', Entomology Division, Forest Research Institute, Dehradun, Uttarakhand, India; under Accession No. NFIC-FRI-21,800.

Paratypes: Uttarakhand: Mandal village (1,600-1,800 m): 1 male. 26.ix.2006-29.ix.2006 and 1 male 4.x.2007; Coll. Arun P. Singh; wingspan: 44-45-mm. Type material in 'National Forest Insect Collection', Entomology Division, Forest Research Institute, Dehradun, Uttarakhand, India; under Accession No. NFIC-FRI-21,800.

Etymology: The species is named after its type locality – Kedarnath Musk Deer Reserve where Mt. Kedarnath (6,838 m), the highest peak in the area, is situated in this Reserve.

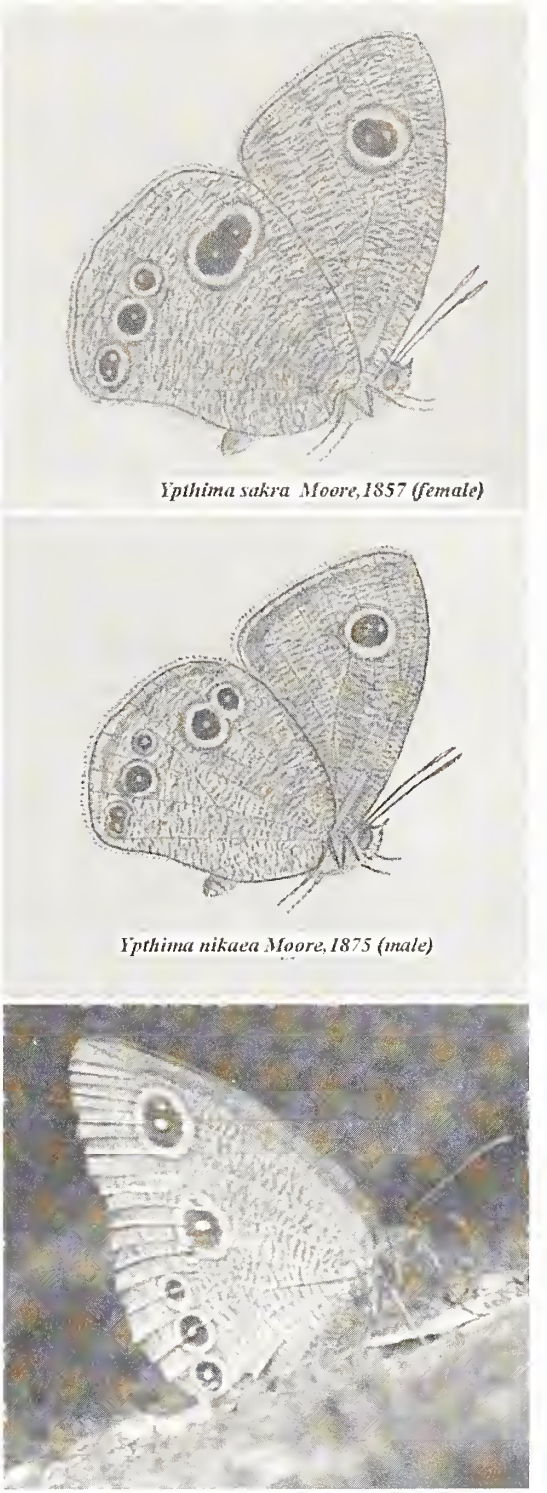

Fig. 2. Under side wing patterns of *Ypthima sakra*, *Y. nikaea* and *Y. kedarnathensis* sp. nov., depicting variation in shape, structure and location of apical ocelli on hind wing

Habits and Habitat

The species was recorded from KMDR on three occasions July 26-29, 2006, September 26-29, 2006 and October 3-8, 2007. It was not represented in the collections during the winter survey (November 2006 - December 2, 2006) when it

was probably hibernating. During the wet season individuals were observed flying low, close to the ground near the forest edge and in openings inside mixed tree stands of sub-tropical and moist temperate vegetation dominated by *Quercus leucotrichophora* and *Rhododendron arboreum* between 1,600-1,800 m.

Relative Abundance

As many as five individuals of *Y. kedarnathensis* sp. nov. were identified from a total of 18 individuals of the *sakra* species group examined in the area. This species was relatively uncommon in relation to *Y. nikaea* found in the area.

DISCUSSION

The new species described is closely allied to *Y. nikaea* but differs from it mainly in the presence of an additional third apical ocellus between v4 and v5 on the hind wing, which is also visible on the upper side of hind wing at the same location. The presence of the third apical ocellus has not been reported, so far, from anywhere in the Himalaya. Even the recent butterfly surveys conducted in Garhwal and Kumaon (Rose and Sharma 1998) did not reveal the presence of such an apical ocellus in the hind wing in any of the species of *Ypthima*. These specimens collected from two different locations represent a new species. As a total of six distinct ocelli are present on the lower side of the hind wing of this species, it can be commonly named the 'Garhwal Six Ring'.

ACKNOWLEDGEMENTS

The present study is part of a project (FRI-348/FED-23) on 'Butterfly diversity in moist temperate forests of Garhwal: Evaluating species of conservation priority and indicator taxa of habitat disturbance' being carried out by Entomology Division, Forest Research Institute (FRI), Dehradun, India and funded by the Indian Council of Forestry Research and Education. I am thankful to the Director (FRI) and Head, Entomology Division (FRI) for extending support and providing facilities. Thanks are also due to Mr. B.C. Pandey and Mr. R. Kumar (Technical Assistants, Entomology Division) for help in field work.

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REVIEWS

1. GOLDEN TREES GREENSPACES AND URBAN FORESTRY by S.G. Neginhal. Published by the author, S.G. Neginhal, 2006. xxxvi + 342 pp. + 72 colour plates. Size: 22 cm x 14 cm. Paper back. Price Rs. 750/-; discounted price to bird watchers: Rs. 650/-.

In this era of urbanization, more and more land is being reclaimed to raise concrete jungles, and there is an urgent need to maintain and restore green spaces by planting trees. But for the common man there is always the question "which tree should I plant?" This book is a useful guide for those who want to know about trees suitable for planting in different localities of urban environment.

The book is in four parts. Parts one and two provide information on trees for rural and urban areas respectively. In all 142 species of trees are described. Part three titled 'Elements of urban planting' has information on tree species suitable for various purposes, i.e. for ornamental avenues, highways, parks, gardens, residential complexes and sacred places. The chapters in this part also deal with nursery techniques, tree maintenance and environmental values of the trees.

The six chapters of part four 'Basics of urban forestry and managing greenspaces' have information on management of trees, green spaces, gardens and parks, and advantage of urban vegetation.

For an easy identification of trees, there are 72 colour plates depicting leaves, flowers and fruits of various tree species. The photographs are of an average quality and have not reproduced well.

I have reviewed earlier publications of Mr. Neginhal, i.e. CITY TREES AND URBAN PLANTING and FOREST TREES OF SOUTH INDIA; this book too is an important publication for tree lovers.

■ NARESH CHATURVEDI

2. VERTEBRATE PESTS IN AGRICULTURE – THE INDIAN SCENARIO by Prof. Shakunthala Sridhara. Scientific Publishers, Jodhpur, 2006. 605 pp. Size: 24 cm x 18 cm. Hardback. Price not given.

This is a heavy tome of more than 600 pages, edited by a professor researching on vertebrate pests, particularly rodents, for the last 33 years. The book is dedicated to the late Dr. Ishwar Prakash, another rodent specialist who died a few years ago. The book consists of 26 chapters written by experts, out of which Prof. Shakunthala Sridhara is the author or co-author of 12 chapters. Some chapters are full of information, not necessarily new but nevertheless interesting. All chapters include relevant references for further reading, which makes this book useful for researchers and scholars.

The cover depicts 17 pest species of vertebrates, including the Asian Elephant, the Sarus Crane, and the Sloth Bear – species listed in Schedule I of the Wildlife (Protection) Act, 1972. However, in most of the chapters, killing of these so-called pests is not recommended, keeping in mind the country's laws and prevalent social attitude against killing of wildlife. Crop raiding by Wild Elephant is a very controversial subject, with no clear-cut solutions. Though she is an expert on rodent pests, Prof. Sridhara has written a well-researched chapter 'Management of Crop Raiding Elephants', covering most aspects of this issue, and referring to 44 relevant papers and theses.

The book is full of spelling mistakes, particularly animal names. For example, Blackbuck is always written 'black buck', and Bluebull as 'blue bull'. Rose-ringed Parakeet should have a hyphen between 'Rose' and 'ringed', similar is the case with Red-vented Bulbul. There are other mistakes, such as Rhesus is written in upper-lower case, while Bonnet is always written in lowercase (p. 479). Some of the scientific names are outdated, e.g. *Gazella gazelle bennetti is* now called *Gazella bennettii*. The langurs have been divided into seven species by C. Groves (PRIMATE TAXONOMY. Smithsonian Institute Press, Washington, DC, USA), but in this book it is treated as one species. Inclusion of latest scientific information by the authors of this chapter would have enhanced the value of this book.

The book also has some funny statements. For example, "Every second day we receive innumerable calls from the residents of Delhi facing monkey problems in their colonies" (p. 471). Why these 'innumerable calls' come 'every second day', why not every day?

Most of the chapters talk about 'management' in the title, but either there is very little discussion on management, or it is cursorily treated, almost as an afterthought. Wildlife management is a very complex issue and our knowledge is still at a very preliminary stage for most species to suggest their 'management'. For example, in Chapter 20 'Rhesus Monkey problems in India and their management', it is

recommended that Transit Homes be established. Once we catch and house 2,000 out the 5,000 Rhesus monkeys of Delhi to this Transit Home, what is the next step? If we keep these 2,000 monkeys in captivity permanently, then how can we call it a Transit Home? The conclusions given in this chapter are very general.

There are many scientific mistakes. For instance, in Table 1 of Chapter 20 (p. 461), it is shown that 95.5% resident of Delhi and Vrindavan are harassed by Rhesus monkeys, and 19% are bitten. Considering the population of Delhi and Vrindavan (20 million), we are talking of about 19 million people harassed by monkeys! Do the authors of this chapter (Ekwal Imam and Iqbal Malik) mean that about 19 million residents are harassed and 2 million bitten, but they are still keeping quite? Indians are known to be very tolerant, but this is the height of tolerance of a public issue! In the same table, it is mentioned that only 5% of the visitors to Tughlaqabad Fort are harassed and 2% bitten. Incidentally, Tughlaqabad is also inside Delhi. So, where does this data stand in the overall data of Delhi? I am shocked to read in this chapter that 88% of the office goers of Delhi are harassed by monkeys. I am lucky for I work in Mumbai - the daily trials and tribulation of this metropolitan is nothing compared to what Delhites face every day! The whole table does not make any sense. With good editing such types of scientific errors in this otherwise good book could have been avoided.

■ ASAD R. RAHMANI

3. SOUTHEAST ASIAN BIODIVERSITY IN CRISIS, by Navjot S. Sodhi and Barry W. Brook. Cambridge University Press, U.K., 2006. 190 pp. Size: 23 cm x 14.5 cm. Hardback. Price: 65 Euros (US $ 120).

This is an expensive 190-page book, with only six chapters, by two well-known field biologists – Prof. Navjot S. Sodhi, an Associate Professor of Conservation Ecology at the National University of Singapore, and Barry W. Brooks, a Senior Research Fellow at the Key Centre for Tropical Wildlife Management, Charles Darwin University, U.K. The book is so full of information that it makes heavy reading. It is for experts, researchers and post-graduate students, not for the general public, as prior knowledge of ecology, conservation issues, and scientific terms is required. Each chapter is a treasure trove of knowledge.

Although the title is SOUTHEAST ASIAN BIODIVERSITY IN CRISES, the book covers only terrestrial biodiversity and not marine biodiversity, which is equally rich and threatened, and perhaps requires another book by the authors. The region covered in this book extends from Myanmar to Indonesia. In this biogeographic region, one has to use superlatives very often. For example, it is one of the most diverse biological regions in the world, one of the most densely-populated regions in the world, it has the highest rate of rainforest deforestation in the world, 4 out of 25 biological hotspots are found here, 40% of the world mangrove is found here, one of the highest regions in the world per unit area in terms of species richness and endemism. I cannot list all the biological and geographic uniqueness of this region given in this book. It is better to get hold of a copy of this wonderful book.

I must say that I enjoyed and was also saddened while reading this book. Enjoyed because it is full of scientific knowledge, but saddened, because most of the natural biological wealth of this region will disappear in another 40-50 years. For example, between 1980 and 1990, 15.4 million ha of tropical forest was destroyed every year. In Thailand, the forest cover has decreased from 53% of the land area in 1961 to 27% in 1991. Singapore was almost fully covered by tropical rain forest 100 years ago, but now only 0.3% of the land is under natural forest.

Each chapter is succinct, well edited and ends with a summary. For every statement or data, either reference(s) is given or information is based on the authors' original research. Within a chapter, the subjects are divided by sub-headings. The flow of the book is very good, despite the fact that it is full of scientific facts, tables, illustrations and diagrams. The best part is that relevant and latest references are given which will help researchers for further reading. The only drawback is that some of the illustrations are not good (e.g. Figs 2.1 and 3.14). How did these illustrations pass through the editor in this otherwise excellently produced book?

Although the book does not concern our region (i.e. South Asia), I think the problems are the same, perhaps exaggerated in South Asia due to dense human population. Some of the problems and solutions are inter-linked. For example, since India banned commercial timber harvest from natural forests about 20 years ago, we started importing timber from Indonesia and Malaysia. If we consider the Earth as one large village, we have not solved the problem of deforestation, but shifted it elsewhere. The solution lies in reducing our consumption and better management of our forests. This book also covers the issue of corruption and mismanagement, rampant in the countries of this region (same as in South Asia). Agriculture subsidy, the most abhorrent form which we see in the USA and Europe, also afflicts South-

east Asia. Not many conservationists realize that there is sometime for direct relationship between agriculture subsidy and biodiversity loss. The inexpensive coffee which you drink sitting in a tiny restaurant in Europe could have resulted in deforestation on the other side of the world. I quote from this book "...during the 1990s, Asian governments with the support of the International Development Bank, promoted intensive coffee (*Coffea robusta*) cultivation in countries such as Indonesia and Vietnam, elevating Indonesia to the world's fourth largest coffee exporter and the second largest producer of *C. robusta* after Vietnam. This move resulted in massive forest conversion, but eventually proved to be economically unsustainable due to overproduction and subsequent price collapse." Sadly, despite this, there are plans to further expand coffee production by the Indonesian government.

I strongly recommend you to read this book. It may not have the philosophical wisdom but the data provided in the book would stir you to sit up and think: Are we doing enough for the protection of biodiversity of the world? Perhaps the time has come for more action, based on science. This is the underlying message of this little book.

■ ASAD R. RAHMANI

4. BIRDS OF PREY OF THE INDIAN SUBCONTINENT, by Rishad Naoroji, illustrations by N. John Schmitt. Published by OM Books International, New Delhi. 2007. 692 pp. Size: 24 cm x 17 cm. Hardback. Price: Rs. 1800/-, £40/-.

This is a book which would make Indian ornithologists proud. It shows that Indian ornithology has advanced from producing basic field guides to the next higher level of specialized taxa-related books. Rishad Naoroji has set a trend by writing a highly commendable book on a difficult subject: birds of prey (raptors); I hope many such specialized books will be published in the near future, particularly on other difficult, but distinct groups such as waders, ducks and geese, warblers, larks and pipits, forest passerines of the Indian subcontinent.

I know Rishad since 1981 when we met first time at Bharatpur. His enthusiasm about raptors is infectious, his energy is boundless. He once spent nine hours in a tiny *machan*, studying and photographing the Pallas's Fish-Eagle, which used to breed in the famous *jheels* of the Keoladeo National Park in the early 1980s. Sadly this majestic bird has stopped breeding there and the *jheels* of this popular Park are now suffering from the water-politics of Rajasthan.

This book has been a pleasure to read and review as Rishad has described in detail all the 69 species of raptors found in the Indian subcontinent. Each species' description is based on extensive literature survey, Rishad's personal field notes, and discussion with experts. In pursuit of his love, Rishad has travelled all over the country, photographing and making meticulous notes on any raptor that he saw. He has also used the help of professional trappers to trap the birds for detailed study of the plumage, colour of bare parts, weight, age and sex. He has also taken thousands of pictures, mainly from hides to study the raptors on nest at close range.

For each species, Rishad has mentioned the most appropriate English name, scientific name, including the name of the author who first described it and the year when the species was named, race(s) if any, local names and their dialectical/regional variations, and etymology (how the scientific name originated). Next come the measurements (length, wingspan and tail), wing, tarsus and weight, followed by detailed identification, description, and then field characters which give tips for field identification. Many field character tips are based on Rishad's own vast field experience, and also on the opinion of other raptor experts.

The next section deals with Status, Distribution and Habitat. In conjunction with the distribution maps given for each species, this section gives up-to-date status and distribution of each species. Rishad has referred to the latest published papers and articles, and consulted experienced ornithologists for writing this section (and all other sections). The distribution maps are a great improvement from the recent field guides (e.g. Grimmett *et al.* 1998, Pamela and Anderton 2005), or the HANDBOOK (Ali and Ripley 1969-1974), which has now become dated as far as species distribution is concerned.

Rishad's 30-years of raptor-watching experience reflects in the next few sections: Behaviour, Food, Voice and Breeding. Vast amount of unpublished information is presented in these sections, sometimes contradicting or correcting the earlier observations. He also gives tit-bits, such as the male of the Pallas's Fish-Eagle has a high-pitched, flutey and mellow call compared to the female's harsher, more guttural and shriller tone. Such minute observations can only come from a person who has spent 800 hrs observing these majestic raptors from a hide!

Besides the wonderful and scientifically accurate text, other highlights of this book are the illustrations, maps and photographs. John Schmitt needs to be complimented for high-quality plates, showing birds in flight, their different postures and plumages (sex or age-related variation in plumage). In 15 plates he has depicted 44 species, some very

confusing such as buzzards, *Aquila* eagles and large falcons. As the book is difficult to carry in the field, I suggest that Rishad and Schmitt bring out a small raptor identification field guide, with plates, good pictures if required, and distribution maps. This would greatly help in popularizing raptor watching in the Indian subcontinent.

I also liked the chapter 'Raptors in Indian History and Mythology'. Rishad felicitously weaves the descriptions of raptors, their behaviour as known to earlier civilizations, origin of falconry and the mythological significance of *Garuda* in the great Indian epics *Mahabharata* and *Ramayana*. According to the *Mahabharata*, all birds of prey are descendents of the primeval *Garuda*, a semi-divine being, and a vehicle of Lord Vishnu. According to Rishad, the original physical basis for *Garuda*, the snake-eater, was most likely the White-bellied Sea-eagle which picks up sea-snakes and eels from the sea. It is interesting to read in this book that our ancient ancestors had divided the raptors according to behaviour, flying abilities, and eating habits. While the Bearded Vulture is glorified in *Mahaviracharita*, the Egyptian Vulture is referred to as a lowly, weak and impotent vulture. The Egyptian Vulture's Sanskrit names *Bhasak* or *Goshtkukut* refer to the bird's habit of frequenting the vicinity of villages and towns, timidly feeding on discarded wastes and carcasses.

In the chapter 'Biogeographical Distribution', Rishad mentions the species of raptors that are expected to be encountered in the ten biogeographical zones of India (based on the classification of Rodgers and Panwar 1988). This chapter also contains some superb habitat pictures, mostly taken by Rishad. Sequential checklist of the species of each zone is given, making it easy for readers to know what to expect in a particular zone.

The chapter 'Locating, Observing and Photographing Raptors' give useful hints, based on Rishad's 30-year old passion and love. Although nest photography is generally discouraged to avoid disturbance to birds, it is sometimes necessary for detailed study of raptor ecology and behaviour. Rishad has studied many raptors on nest from the hide but he always saw that disturbance is kept to minimum. For example, while studying Red-headed Falcons in Jamnagar, he built the hide during evening hours only when heat was less so the birds were less stressed. He further suggests that not more than 45 minutes a day should be spent on the actual construction of a hide, which enables the birds to get accustomed to the raising structure over a period of time. As a true conservationist, he advises "even after taking all precautions, the birds appear stressed; the whole operation should immediately be suspended or abandoned. The safety and well-being of the birds should be the primary consideration rather than data collections or photography."

The Bibliography, which consists of 50 pages, starts with General References and then Species References. Almost all scientific papers, books and reports relevant to South Asian raptors are mentioned, sometime as latest as 2006 (the book was published in the last quarter of 2006).

One of the most interesting and relevant chapters is 'Conservation and Management'. Raptors being at the apex of the food chain are a good indicator of the health of the environment. The way raptors have declined in India and elsewhere, indicates that all is not well in our environment. Besides the dramatic decline of *Gyps* species of vultures, due to the killer-drug Diclofenac, which has caught the attention of the public and the government, other species are also declining due to the slow poison by pesticides, herbicides, weedicides and rodenticides. Unlike in the so-called developed countries, we do not have direct persecution of raptors, but many of them, particularly large falcons, are now smuggled to the Middle East for falconry purpose. Forest dwelling raptors (e.g. Bazas, hawk-eagles, falconets) have suffered due to habitat destruction, while the grassland-dwelling raptors (harriers, kestrels, Black-shouldered Kite) find it difficult to find foraging and roosting areas as >95% of the grasslands are gone. Despite the fact that pesticide is playing havoc with our raptor populations, large-scale all-India study on the negative impact of pesticides on these species has not been done in our country. Rishad found that even in the closely-guarded Corbett National Park very high levels of pesticide was found in Grey-headed Fish-eagle, so one can imagine the pesticide impact on the raptors (and other birds) of the countryside where use of these chemicals is widespread.

In the end, I can only say that BIRDS OF PREY OF THE INDIAN SUBCONTINENT is a high-quality book, not only in text, photographs, illustrations and maps, but also in production and slick editing. I recommend it highly. It is a book that will always remain as something special in my personal library.

■ ASAD R. RAHMANI

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MISCELLANEOUS NOTES

1. THE EASTERN LIMIT OF DISTRIBUTION OF THE HANUMAN LANGUR *SEMNOPITHECUS ENTELLUS* DUFRESNE[1]

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The Hanuman or Common Langur *Semnopithecus entellus* Dufresne is among the commonest primates of the Indian subcontinent and is the most abundant of the colobines, i.e. langurs. Its general distribution covers almost the entire India, excluding the deserts and the snow-capped higher Himalaya. It is a very well documented species; however, towards the eastern part of its range, its distribution was imperfectly known. In Bangladesh, the only population is in western Bangladesh, in Kushtia and Jessore districts (Khan 1985), which suggested that the Padma and Meghna rivers formed its eastern limit in that country. In Bhutan, it occurs only towards south-west (Choudhury 1990, 1997; Wangchuk 1995).

So far no specimen has been recorded from anywhere in north-east India except northern West Bengal and Sikkim. A large number of reports were received from different parts of north-east India, e.g. Arunachal Pradesh (Chatterjee 1989; Kaul 1999), Assam (Choudhury 1989) and Mizoram (Khati 1995). However, all these were misidentification of the Capped Langur *Trachypithecus* (=*Presbytis*) *pileatus*, which is common in the region. Tikader (1983), however, tried to limit its eastern boundary, which was nearer to the actual. He mentioned River Teesta in northern West Bengal as its easternmost limit. Roonwal and Mohnot (1977) mentioned of a subspecies in northern Myanmar (*P.e. shanicus*) creating further confusion regarding the species' eastern limit because it suggested occurrence in north-east India also! However, it is clear that no such race occurs in northern Myanmar and *shanicus* is no longer considered a form of *entellus* (Brandon-Jones *et al.* 2002; Corbet and Hill 1992; Groves 1993, 2001). There were also reports from south-eastern areas of Tibet, China (Qiu and Bleisch 1996).

All such reports of Hanuman Langurs from different parts of north-east India and adjacent areas of south-eastern Tibet appeared to be misidentification of the Capped Langur, which has seasonal change in pelage colour and some races look entirely grey. There were more erroneous records, Anon. (1997) reported of its occurrence in Tibet, east of the Tsangpo river, while Das *et al.* (1995) included East Garo Hills, Meghalaya as part of its range. But none could refer to any specimens.

Corbet and Hill (1992) erroneously included the entire north-east India in the range map for Hanuman Langur (p. 175), while Prater (1948) did not mention anything specifically on north-east India or Assam. Qiu and Bleisch's (1996) report that it occurs in Yarlung Zangbu region of Tibet had again raised confusion as they had mentioned of specimens also. But on being asked to clarify (Choudhury 1997), they could not defend their report and said that the specimens were not seen or examined but 'reported' (Bleisch 1997; Qiu 1997). George Schaller during his visit to Guwahati in February 2000 had a discussion with me regarding the langur species found in south-eastern Tibet near India's border and the adjacent areas in Arunachal Pradesh. Subsequently, he confirmed that the langurs found near the Tsangpo belt were Capped and not Hanuman as stated in Choudhury (1997).

During field studies for primates in north-east India since 1984, I could not confirm the presence of Hanuman Langur and all the reports were found out to be of Capped Langurs, some of which, especially in parts of higher Himalaya and Naga Hills look entirely grey. In northern West Bengal, I found it to occur east of the Teesta river, thus contradicting Tikader (1983). It is, however, very rare and occurs mainly in Chunabhati and Buxa fort area of Buxa Tiger Reserve, west of the Rydak river. In Bhutan, Wangchuk (1995) reported that the Hanuman Langur occurs as far east as the Puna Tsang Chu or Sankosh river. Thus, it is now established that the eastern limit of Hanuman Langur's distribution is the Rydak river in northern West Bengal, India; Sankosh or Puna Tsang Chu in Bhutan, and Padma and Meghna rivers in Bangladesh (historically Jamuna also).

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2. MACAQUES 'KIDNAP' INFANT PALM CIVETS[1]

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During a study of Civet ecology in Hlawga Wildlife Park (2000-2003), I observed two instances of 'adoption' or 'kidnapping' of baby Palm Civets. Hlawga Wildlife Park in Myanmar is a 6.24 sq. km protected area, dominated by secondary mixed deciduous forest, located 35 km north of Yangon. The Park has a mixed fauna of large mammals, such as Sambar (*Cervus unicolor*), Hog Deer (*Axis porcinus*), Red Muntjac (*Muntiacus muntjak*), Eld's Deer (*Cervus eldi*), Wild Boar (*Sus scrofa*) and Gaur (*Bos frontalis*), some introduced from other areas in Myanmar (Su Su 2003). It has a current population of *c.* 280 Rhesus Macaques (*Macaca mulatta*). The Park is frequently visited by local tourists who feed Sambar, Hog Deer, Eld's Deer and Macaques with food bought from local vendors.

On April 22, 2001, my assistant and I were approached by a group of macaques seeking food. One adult male carried a small black animal that was crying like a kitten. We soon identified it as an infant Palm Civet (*Paradoxurus hermaphroditus*). The Palm Civet is the most common small carnivore in the Park. We used food to coax the monkey to surrender the baby Civet, but the macaque held on to it firmly. When we tried chasing, it ran away and climbed on a tree, still holding the baby. The Park's forestry staff reported that they had seen the macaque with the baby Civet for three days. We observed the macaque with the live baby Civet daily for the next three days, the baby's voice becoming weaker each day. Two days later, the Civet was dead but was still being carried by the macaque.

A week after this event, we saw another male macaque, a smaller male, carrying another baby Palm Civet. This infant Civet was alive but was not vocalizing. Unfortunately, we were unable to observe this macaque on subsequent days. It seems probable that these macaques appropriate baby Palm Civets that they encounter in civet nestling sites, in trees. Macaques are known to show paternal behaviour towards infants of their own species (Schino *et al.* 1995), but we have not heard of allo-mothering behaviour in this species.

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3. LIVESTOCK-DHOLE CONFLICT IN WESTERN BHUTAN[1]

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Dhole (*Cuon alpinus*), a pack-hunting canid, is a coursing predator of the Asian jungles. It preys on wild ungulates such as Sambar (*Cervus unicolor*), Chital (*Axis axis*), Barking Deer (*Muntiacus muntjak*) and Wild Pig (*Sus scrofa*) and also on livestock when available. Bhutan has 72% forest cover (Tshering and Wangchuk 2003), and wild ungulates such as Sambar, Wild Pig and Barking Deer, which provide a suitable habitat for Dholes. The Indian subcontinent has four subspecies of Dholes (Johnsingh 1985) and of these, possibly two occur in Bhutan – *C.a. primaevus* in the lower and middle Himalayan regions, and *C.a. laniger* in the higher regions. The propensity of Dholes to attack livestock, however, had resulted in the people of Bhutan nearly eradicating Dholes in the 1970s by poisoning their kills. Subsequently, for nearly 30 years, Dholes as a problem species were forgotten. Absence of dholes led to another problem, wild pigs, which caused enormous damage to agricultural crops (Wangchuk 2004). Dholes reappeared in many parts of Bhutan in the late 1990s, and started causing considerable damage to livestock, as the villagers in many parts of Bhutan leave their livestock to graze in the forest, sometimes even for weeks at a time.

In order to assess Dhole depredation on livestock, a three-week study was carried out in April-May 2004 in Toeb Geog (block), Thimphu Dzongkhag (district) in western Bhutan, as part of a training program to 15 wildlife personnel from different parts of Bhutan. A questionnaire to gather information on Dhole depredation was developed. The participants were divided into five teams and were guided to collect data on Dhole depredation from six villages on the left bank of Toeb Rong Chhu (a stream in a deep gorge) and four on the right bank. The right bank villages were much more developed due to the Thimphu-Wangdue Highway. In each village, three persons representing different households/ families (n=30) were interviewed based on the questionnaire (Johnsingh *et al.* 2004).

The key findings are as follows. Average family size on the right bank, which possibly has more employment opportunities due to the highway, was 8.42, while on the left bank it was 5.78. Average number of livestock held by a family on the right bank was 6.67 and left bank 6.44. Twenty-two respondents, who had lost their livestock to Dholes, said that all attacks and kills were made while the cattle were left in the jungle. Interestingly, Emou village, which is on the left bank, which in 2004 had 16 cattle and 4 pigs, had not suffered a single livestock loss so far, as the animals were taken to jungle for feeding during the day and stall-fed at night. All the 30 respondents said that livestock penned near homes were never attacked by Dholes. As seen in other parts of Dhole range, there were no attacks on people, and the number of Dholes in the packs averaged around eight.

Livestock numbers on the left bank in 2004 were 80 cows, 12 oxen, 9 calves and 17 pigs. Livestock killed from 1999 to 2003 was 6 cows, 10 oxen, and 3 calves. On the right bank, the livestock numbers in 2004 were 48 cows, 24 oxen and 9 calves. Livestock killed during 1999-2003 was 15 cows, 24 oxen, and 8 calves. More oxen and fewer cows are killed in proportion to availability, and this indicates that the cows are protected well while oxen do not get the needed protection. Annual loss per family due to Dhole depredation on the left bank was US $ 23.4 (Nu. 1,055) and the right bank US $ 85 (Nu. 3,833). This loss is substantial, considering that the annual income of villagers in Bhutan is between US $ 400 and 600 (Nu. 18,000 to 27,000).

Based on the answers of 30 respondents, it was concluded that next to Dhole, Leopard (*Panthera pardus*) was the major predator on livestock (11 reported cases of attacks) followed by Tiger (*P. tigris*, 4 cases) and Black Bear (*Ursus thibetanus*, 1 case). One interesting observation during the survey was that most villagers prefer Dholes to Wild Pigs, as Dholes prey on Wild Pigs. Protecting fields from Wild Pigs is much more difficult than protecting livestock from Dholes. We suggest that with suitable conservation awareness programmes the Emou model should be followed for other villages. Compensation for Dhole livestock kills, if given, could become very expensive for the Government of Bhutan.

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4. FIVE-STRIPED PALM SQUIRREL (*FUNNAMBULUS PENNANTII*) IN RISHI VALLEY, CHITTOOR DISTRICT, ANDHRA PRADESH[1]

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According to some recent publications on Indian mammals, the Five-striped Palm Squirrel (*Funnambulus pennantii*) is a species of northern India, found south of *c.* 16° N, i.e. around Dharwar in the west (Nameer 2000; Menon 2003), and on the east and in central India the limit is indicated as around 20° N (Corbet and Hill 1992). It is replaced in southern India by the closely related and similar looking Three-striped Palm Squirrel (*Funnambulus palmarum*). Earlier writers like Sterndale (1884) treated both species as one till around the beginning of the twentieth century (Sathasivam 1999). Prater (1980) on the other hand says: "The Five-striped Squirrel is common in northern India, particularly in the drier and more arid portions, and extends into the dry plains of the south. The Three-striped species predominates in the south, and in the moister parts of western and eastern India. Both species may, however, be found living in the same area."

I have been observing the Five-striped Palm squirrel in the Rishi Valley area (near Madanapalle, Chittoor district of Andhra Pradesh), which is 13° N, for the past several years and have, in the last few months, made close observations on them. These squirrels are not shy and if one remains quiet they are seen at a close range.

These squirrels are found in arid, scrub and boulder covered parts of the valley, away from cultivation and habitations, though they could be seen close to agricultural lands occasionally. I have been seeing at least four animals on the roadside hedges (agave) near Rishi Valley, and suspect there may be more animals. I have also often seen them at another location in similar dry habitat about two kilometres away from the location. It appears unlikely that the population in Rishi Valley is introduced as the squirrels are also noticed in appropriate habitats, even 20-25 km away from Rishi Valley (Suresh Jones pers. comm.).

It is unfortunate that all books distinguish these two species only on the basis of the number of stripes. Some features that I have noticed of these animals that are distinct, apart from the habitat segregation are: their calls that appear sharper than the Three-striped species, which are abundant in the cultivated areas and habitations inside the school campus. The presence of a dark stripe (eye-band) that contrasts with the white cheeks; an indistinct supercilium is also seen above this dark stripe. The Five-striped appears slimmer and the dark stripes on the back appear to contrast more with the body coloration. The additional pale stripes on the flanks are clearly noticeable in some individuals, even without binoculars. The tail appears less bushy.

I am not sure if these features are uniformly present in all individuals across the country or are peculiar to the population in Rishi Valley. Even here they appear indistinct in some individuals. Only some of the photographs on the internet and publications confirm this. According to Kumaran Sathasivam (*in litt.*), "I have found these stripes to be not conspicuous in the field in Delhi. I had to look carefully to discern the five stripes. The books too say the outer stripes are obscure in skins."

Enquiries with local villagers revealed that they do know the existence of two species that co-exist in their environs, and they are aware of the habitat preference of the two species. They distinguish them based on their habitat preferences, coloration and tail. They do not seem to have a distinct name though (Suresh Jones pers. comm. in 2005).

In view of the above observations, I feel we need to re-examine the skins of all Palm squirrels in Indian museums from various localities, and also conduct field research to rework the field marks, exact distribution, and taxonomy of these common mammals.

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5. THE GAUR *BOS FRONTALIS* LAMBERT IN MANIPUR[1]

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The Gaur *Bos frontalis* Lambert is distributed in north-eastern India in discrete populations (Choudhury 2002). The Gaur population in Manipur is poorly known and is believed to be very small (Choudhury 1992). Field trips were made in April 1988, January 1996, January and October 2001, and February 2002 to assess the current status of the Gaur in Manipur. The state of Manipur (23° 49'-25° 42' N, 93° 00'-94° 45' E; 22,327 sq. km in area), (Fig. 1) has two physiographic units – Manipur or Imphal Valley and Manipur Hills. The highest ranges are towards north with Mt. Tenipu or Iso (2,900 m above msl) as the highest peak. The lowest elevation is in the riverbeds near the Assam-Manipur border (less than 50 m above msl).

Till about 1950s, the Gaur was widespread all over the hills in the state, especially in the districts of Ukhrul, Senapati, Tamenglong, Churachandpur, Chandel and Jiribarn subdivision of Imphal district. Stray animals were reported from the hilly areas of Thoubal and Bishnupur (Bishenpur) districts. By then, however, the Gaur has vanished from the Valley. In fact, even at the turn of the 20th century, the species was scarce near the Valley. The Gaur was never common in recent memory as its meat was considered a major delicacy by all the tribes (Zeliangrong, Mao and Tangkhul Nagas, Kukis, Hmars, Biates, Paites and Mizos), and hunting was a regular feature. In the 1960s, when the insurgency started, modern firearms became handy resulting in phenomenal increase in poaching. With the gradual increase in human population, the destruction of forest through felling and *jhum* cultivation has also increased. By 1970s, the main Gaur strongholds remained only in the western and eastern hills with small populations elsewhere. By 1980s, they vanished from the northern hills except for stray individuals from the Dzuko valley and adjacent hilltops. In the 1990s, the Gaur survived only in a few areas, namely (1) Anko / Ango Ching range and Shiroi; (2) Bunning area; (3) Jiri-Makru forests; (4) Chandel district; (5) Tolbung forests and stray individuals elsewhere. In the meantime, the human population of Manipur grew from 1.07 million in 1971 to 2.29 millions in 2001 (GoI 2001), i.e. more than double in two decades indicating phenomenal increase in *jhum* cultivation.

The main Gaur populations are now confined to the five areas where they were in the 1990s, but in a reduced

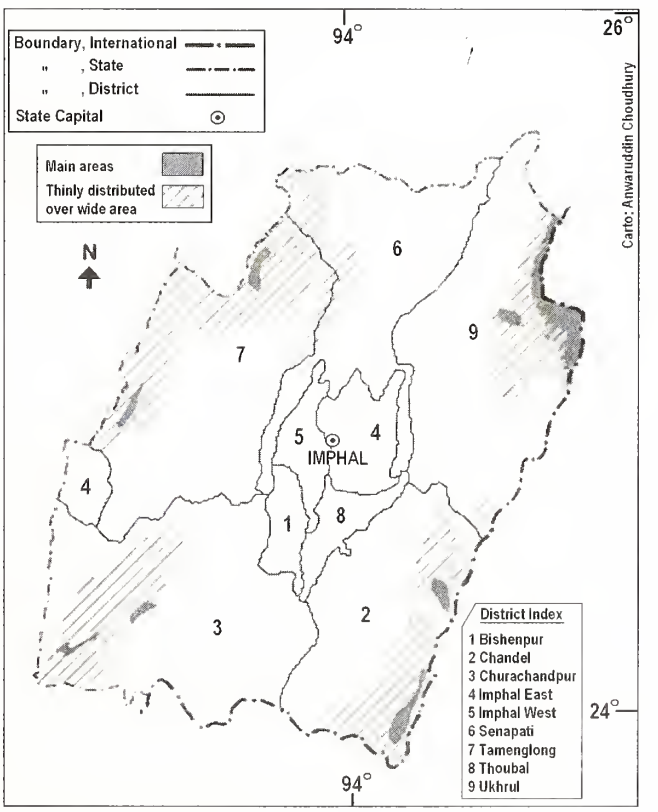

Fig. 1: Distribution of Gaur in Manipur

number. The approximate area and numbers are as follows: Anko / Ango Ching range and Shiroi (300 sq. km) of Ukhrul district in the north-east. This population has contiguity with forests in Myanmar and about 40-80 Gaurs could still be found. Bunning Wildlife Sanctuary (115 sq. km) and Jiri-Makru forests (198 sq. km) of Tamenglong district in the north-west have a small population of less than 30 animals. In Chandel district, a few are seen in the Yangoupokpi-Lokchao Wildlife Sanctuary (184.80 sq. km), but less than 30 animals are found in the forests (>50 sq. km) towards south, which also move to the Myanmar forests. In Tolbung Reserved Forest (>100 sq. km) and Kailam Wildlife Sanctuary (187 sq. km) of Churachandpur district, only stray animals or groups survive.

From the above account, it seems that the total number of Gaur in Manipur is only 120-160. The long-term survival of Gaurs in Manipur is bleak as the existing numbers are not only very small, but are also severely fragmented with no possibility of contiguity. The protected areas, where a few gaurs still survive, are inadequately protected.

Habitat destruction and poaching continue to be major threats. The main cause of decline is unreported poaching. Protection measures in the sanctuaries should be strengthened. Anko/ Ango Ching range and Shiroi should be declared wildlife sanctuaries. Conservation education among villagers living along the fringe areas of PAs with the help of NGOs is also strongly recommended.

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6. SIGNIFICANT NEW LOW ELEVATION RECORD FOR GORAL *NEMORHAEDUS GORAL* (HARDWICKE)[1]

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The Goral (genus *Nemorhaedus*) is represented in the Indian subcontinent by three forms, which are treated as different subspecies as well as species – *goral*, *baileyi* and *caudatus* (Choudhury 2003; Corbet and Hill 1992; Ellerman and Morrison-Scott 1951; Wilson and Reeder 1993), however, there was no proper description of upgrading these as distinct species except popular descriptions, such as Groves and Grubb (1985). There is also significant colour difference within a species or even subspecies. In Himalayan goral *N. goral*, which is grey-brown, although the tendency is not to recognize *hodgsoni* as a subspecies, latter form is rufous-brown and distinct in the field. The Chinese goral *N. caudatus* in the Himalaya and Mishmi Hills is dark grey, while form *evansi* in Mizoram is brown.

The goral occurs in the hills and mountains, preferring cliffs and rocky hill sides from elevations ranging from 900 to 4,250 m (Prater 1980), from 820 m up in Pakistan (Corbet and Hill 1992). It is only at higher latitudes such as Ussuri area of eastern Russia that it occurs at the sea level (Schaller 1977). In the lower latitude, including the Indian subcontinent, the known lower altitudinal limit was 820 m. The altitudinal movement in the Himalaya is mainly noticed in winter due to heavy snowfall in the higher elevations. I here report an interesting observation where goral was recorded at a very low elevation at latitudes it was never recorded earlier.

On November 28, 2004, three boatmen while pulling a boat upstream had noticed two 'wild goats' – goral or serow – on a cliff on the right bank of the Manas river in Royal Manas National Park, Bhutan (26° 49' N, 90° 56' E) (Fig. 1). The boat was pulled to Panbang, a sub-divisional headquarter in Bhutan for me where I was camping. The next day, while boating downstream, the boatmen showed me the spot, but the 'wild goats' were not there. Suddenly one of the boatmen

Fig. 1: Map of Bhutan

shouted, and I could see one goral a few metres from the previous day's site. It was on the cliff that was covered by sparse vegetation. It then slowly moved behind scrub. The elevation where the Goral was seen was 110 m above the mean sea level. Sighting record of Goral at such an elevation was never reported and I even did not expect. I had observed Serow at 100 m in the Himalayan foothills only in winter, and in south of the Brahmaputra, sporadically round the year, but the sighting of Goral was interesting. From the range, it seems to be a Himalayan Goral *N. goral*, but it was rufous-brown indicating that it was of form *hodgsoni* Pocock.

ACKNOWLEDGEMENTS

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7. DISCOVERY OF LEAF DEER *MUNTIACUS PUTAOENSIS* RABINOWITZ *ET AL.* IN NAGALAND WITH A NEW NORTHERLY RECORD FROM ARUNACHAL PRADESH[1]

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Muntjacs *Muntiacus* sp. are common and widely spread across India as well as elsewhere in Asia; however, it seems to be an interesting group, with a number of recent discoveries of new species from southeast Asia (Schaller and Vrba 1996; Rabinowitz *et al.* 1999). One such new species was described from northern Myanmar in 1999 and was named *Muntiacus putaoensis* (Rabinowitz *et al.* 1999). This is a small deer and has been named as 'Leaf Deer' because local hunters called it so in their dialect. Their area of occurrence was in extreme northern Myanmar, around Putao. This discovery indicated the Leaf Deer's possible presence in India, especially in eastern Arunachal Pradesh. In north-east India, the Indian Muntjac *M. muntjak* is the most abundant of all deer species occupying a wide variety of habitats and altitudinal ranges.

In 1993-1994, while surveying eastern areas of Arunachal Pradesh, in Lohit and Changlang districts, I came across reports of a small deer resembling a muntjac from the Lohit and Changlang districts, both from areas bordering Myanmar. At that time *Muntiacus putaoensis* was not described, and since there was no good collection of muntjac species in Indian museums, comparison was difficult. Though

Fig. 1: Map showing inferred area of distribution of the Leaf Deer

I did not follow up by further surveys, I was intrigued by the stories of the small deer.

In 1997, Rabinowitz and Khaing (1998) found small sized muntjacs in adjacent areas of northern Myanmar and later described it as *Muntiacus putaoensis* (Rabinowitz *et al.* 1999). In August 2001, I visited the collections at the Wildlife Conservation Society and American Museum of Natural History to examine the skulls of the Leaf Deer obtained from northern Myanmar by Rabinowitz and confirmed that the specimens from Lohit and Changlang were that of the Leaf Deer (undescribed at that time) (Choudhury 2003). Later, Datta *et al.* (2003) found evidence from elsewhere in Changlang district.

Tuensang and Kiphire districts of Nagaland (25° 35'-26° 24' N, 94° 35'-95° 12' E) are hilly and mountainous. The main range runs along the India-Myanmar boundary and is the highest in mainland Asia south of Himalaya-Mishmi Hills. The highest point is Mt. Saramati, 3,842 m above msl, which is also the highest peak in mainland Asia – south of the Himalaya. Elevation ranges from 1,000 m. The main vegetation type ranges from subtropical broadleaf and temperate broadleaf forests to subalpine scrub atop Saramati. Small areas of subtropical and temperate conifers are also found. Dibang Valley and Upper Dibang Valley districts of Arunachal Pradesh (28° 0'-29° 27' N, 95° 15'-96° 36' E) are also hilly and mountainous being part of Mishmi Hills.

Discovery in Nagaland

Although I had a plan to survey the eastern mountains of Nagaland bordering Myanmar for possible Leaf (*M. putaoensis)* and Black muntjacs (*M. crinifrons*), my visit in February 2004 was on an awareness campaign as part of OBC-WildWings Conservation Award. During discussion with local hunters and villagers in the Noklak area (26° 12' N, 95° 00' E) of Tuensang district, at least four hunters reported of a small deer that resembled the commoner Indian muntjac. According to them it lived in higher areas of the mountains that separate India from Myanmar. During winter they even hunted it amidst frost or snow, which indicate that the species prefers higher elevation. I looked around in the Noklak town

Table 1: Skull measurements (cm) of the lone specimen (Male) examined

SKULL	
GSL	15.4 up to canine
CTL	5.4
ZB	7.2
BW	5.5
NW	1.8
IOB	3.8
PW	3.2
MTL	8.7
CL (left)	1.3
ANTLER	
LPL	6.1
RPL	5.8
PC	2.9
PG (base)	4.2
PG (tip)	3.4
PG (gt)	4.5

Skull: GSL = greatest skull length; CTL = length of cheek teeth; ZB = zygomatic breadth; BW = greatest width of braincase; NW = greatest width across nasals; IOB = inter-orbital breadth; PW = palatal width between third molars; MTL = length of maxillary toothrow; CL (left) = canine length
Antler: LPL = left pedicle length; RPL = right pedicle length; PC = pedicle circumference; PG (base) = gap between pedicles at their base; PG (tip) = gap between pedicles at their tip; PG (gt) = greatest gap between pedicles.

as well as village and then a number of other villages such as Pangsha, New Pangsha, Dan, etc. Everywhere, at least the regular hunters were convinced that there is indeed a small muntjac in the higher areas east, north-east and south-east of Noklak. After repeated search in these villages at last I could locate a skull of a male at Pangsha village (26° 14' N, 95° 06' E). The elevation of the village ranges from 1,200 to 1,300 m and the Leaf Deer were reportedly encountered or shot at 1,700 m to above 3,000 m. The measurements of the skull are given in Table 1. The skull was almost complete except for some minor damages that did not allow measurements of condylobasal length, basal length and nasal length. The greatest skull length was also not complete, but up to the canine only. In the skull, the inward bend of pedicles was conspicuous.

Further records from Arunachal Pradesh

In March 2004, I confirmed its occurrence farther north in Dibang Valley (Choudhury 2004; details are being analysed). Two specimens (head with antler) were examined, which were shot from the subtropical forests towards north-east of Mehao Wildlife Sanctuary (outside the sanctuary area). This record has extended the range of the deer farther north (so far northern-most).

These discoveries significantly extended the distribution of the leaf muntjac further south (26° 14' N; from 26° 33' N in Rabinowitz *et al.* 1999) and west (95° 06' E; from *c.* 96° 30' E in Datta *et al.* 2003) in Nagaland, and also towards north (28° 20' N; from *c.* 27° 35' N in Rabinowitz *et al.* 1999) in Arunachal Pradesh. In Nagaland, it certainly occurs farther south covering Saramati and at least up to the gorge of Tizu river that flows into Myanmar. This also indicates that the Leaf Deer has wider distribution across the western mountainous tracts of Myanmar as well as the intervening mountains between Noklak in Nagaland and Pangsu in Arunachal Pradesh (Fig. 1).

Because of habitat contiguity and similarity in terrain, vegetation and climatic conditions, it is likely to occur farther west in Dibang valley in Arunachal Pradesh, as well as a possible area in southeast Tibet (China), where the Lohit river has entered India (Fig. 1). Except Fakim Wildlife Sanctuary (6.4 sq. km), the entire potential range in Nagaland is outside any protected area. A large protected area has already been recommended as 'Saramati-Fakim' covering an area of 500 sq. km that also includes the confirmed habitat of the Leaf Deer near Noklak (Choudhury 2001). Besides early declaration of this protected area, further surveys in Saramati and other mountain ranges on India-Myanmar border falling in Mon, Tuensang, Kiphire and Phek districts in Nagaland and Ukhrul district in Manipur are strongly recommended.

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At Wildlife Conservation Society and American Museum of Natural History, both in New York, I thank Kathleen Conforti, Program Manager and Bob Randall, Manager of loans and visitor services, for their help during my visit in August 2001. I also thank Alain Rabinowitz for kindly allowing me (through Kathleen) to examine the specimens in his chamber during his absence in August 2001.

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8. STATUS OF HOG DEER *AXIS PORCINUS* ZIMMERMANN IN LAKHIMPUR AND DHEMAJI DISTRICTS OF ASSAM[1]

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The Hog Deer *Axis porcinus* Zimmermann was widely distributed in the plains of north-eastern India, especially in valleys of the Brahmaputra and Barak rivers, and Manipur. Over the years, the grasslands in the plains gave way to settlements and paddy cultivation, and the species was confined mainly to some of the protected areas only. However, in two districts of eastern Assam, Lakhimpur and Dhemaji, the Hog Deer is still found in scattered pockets outside the protected areas due to relatively low pressure of human population (Choudhury 1997). I report their relative status in 1989-1991 (I was posted at Dhakuakhana as SDO-civil), 1994-95 (I was posted at Lakhimpur as Project Director of rural development) and 2002 (short field trip) in these two districts.

In 1989-91, in Lakhimpur district (Fig. 1), the species was present in the Pabho Reserve Forest (RF), Borchapori, Kadam RF, chapories of the Subansiri river near Chowldhowaghat and many localities in Dhakuakhana subdivision (Choudhury 1991) (Matmota, Tekeliphuta, Lutachur, Basudeo, Andharu, Bordoibam-Bilmukh and Gohain chapori, Sampora near Ghilamora, Borkolia and stray animals elsewhere). Stray animals were also observed in Dulung, Kakoi and Ranga RFs, especially along the rivers. However, in all these pockets the number of the Deer was low, never exceeding 40-50. In Dhemaji district, however, large populations existed in Kobo chapori (> 200), Bordoloni (>100), Poba RF, Jamjing RF (>50), Sengajan RF, Jiadhal RF, Subansiri RF, chapories near Sonarighat, Semen chapori, other chapories on the Brahmaputra river, and stray animals elsewhere. The total estimated population in Lakhimpur and Dhemaji was 250-300 and 550-650 respectively.

In 1994-95, in both Lakhimpur and Dhemaji districts, the species was present in all the sites of 1989-91, but in slightly lesser numbers.

In 2002, significant changes were noticed in Lakhimpur district, the species was virtually absent from Pabho RF, with stray animals reported. In Borchapori and Kadam RF, the changed course of the Subansiri river had eroded the habitat to almost half. It was a case of 'river capture' where the small Ghagar river about 50 m wide was captured by the big Subansiri river about 500 m wide. The chapories of the Subansiri river near Chowldhowaghat and many localities in Dhakuakhana subdivision (Matmota, Tekeliphuta, Lutachur, Basudeo, Andharu, Borkolia and stray animals elsewhere), however, continued to hold small numbers of the Deer. The number in

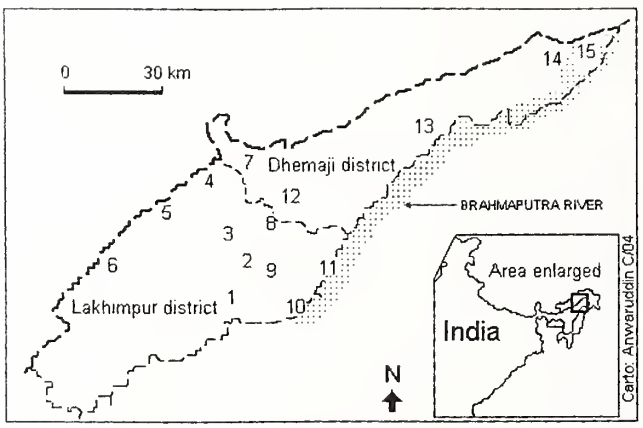

Fig. 1: Map showing some of the places mentioned in the text.
1. Pabho RF; 2. Borchapori; 3. Kadam RF; 4. Dulung RF;
5. Kakoi RF; 6. Ranga RF; 7. Subansiri RF;
8. Bordoibam-Bilmukh and Gohain chapori; 9. Basudeo;
10. Tekeliphuta; 11. Matmota; 12. Bordoloni;
13. Jamjing and Sengajan RFs; 14. Poba RF; 15. Kobo chapori

Sampora near Ghilamora was reduced to a few individuals, while those in Bordoibam-Bilmukh were almost extirpated. Stray animals were still observed in Dulung, Kakoi and Ranga RFs, especially along the rivers. Bordoibam-Bilmukh is a bird sanctuary and is partly in Lakhimpur and partly in Dhemaji districts; the main deer habitat was in Lakhimpur district. The entire grassland and reed bed along the western fringe of the Sanctuary was destroyed by a section of the villagers who were opposed to the declaration of a sanctuary. While a few deer could escape, the rest were killed for the pot. The survivors (about 20) are still seen in Gohain chapori towards west of Bordoibam-Bilmukh. In Dhemaji district, however, the populations continued to exist in the earlier sites, but in depleted numbers. Kobo chapori had suffered heavily in the flash flood in 2000 and there were fresh encroachments. The estimated numbers were <200. In Bordoloni also, the reed and grass cover had been reduced and the numbers may be <80, Poba RF, Jamjing RF (<40), Sengajan RF, Jiadhal RF, Subansiri RF, chapories near Sonarighat, Semen chapori, other chapories on the Brahmaputra river and stray animals elsewhere. The total estimated population in Lakhimpur and Dhemaji was 150-200 and 450-550 respectively.

The population in Kobo chapori is contiguous with those in D'Ering Memorial Wildlife Sanctuary in Arunachal Pradesh. Both these areas had a few hundred Hog Deer until 1980s.

The first major threat to the Hog Deer came at the end of 19th century when large number of people from Majuli area of Jorhat district and also from other parts of Jorhat and Sivasagar districts settled down by clearing grassland in the floodplains of Lakhimpur and Dhemaji. Then in early 20th century, a part of Lakhimpur was occupied by people from East Bengal; part of Pabho RF is also encroached. In the later part of the 20th century, some Bodo tribals from Assam-Nagaland border had moved into some parts of Dhemaji district after disturbance in the former area. They have occupied prime Hog Deer habitat such as Jamjing RF and Semen chapori.

Habitat destruction and poaching, with guns and snares, continue to be major threats. Each year, a chunk of the grassland is added to the mustard cultivation and unless conservation measures are taken, the future of the animal is bleak.

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9. FIRST SIGHTING OF WHITE-TAILED EAGLE *HALIAEETUS ALBICILLA* IN BUMDELING WILDLIFE SANCTUARY, BHUTAN[1]

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The White-tailed Eagle *Haliaeetus albicilla* is listed by BirdLife International (2004) as 'near threatened'. In the north-eastern part of the Indian subcontinent, including Bhutan, it is an occasional winter visitor moving upstream of larger rivers (Choudhury 2000; Inskipp *et al.* 2004). In Bhutan, it was recorded from the western part of the country in Punakha and Thimphu *dzongkhags (dzongkhag* = district) (Inskipp *et al.* 2004). I here report of a sighting in far eastern Bhutan in Bumdeling Wildlife Sanctuary (Fig. 1).

On January 18, 2006, I left Trashi Yangtze town (in Bhutan) before dawn and drove towards Bumdeling Wildlife Sanctuary to catch up with the roosting Black-necked Cranes *Grus nigricollis* that take off early in the morning. While returning, we noticed a large bird perched on a tree by the

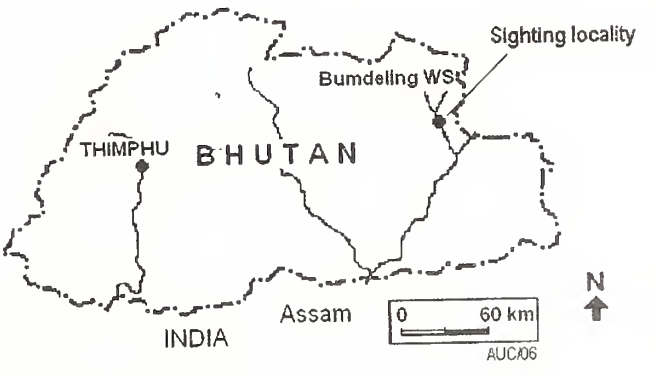

Fig. 1: Map of Bhutan showing the locality of sighting

Khulong *chu* (*chu*=river). Khulong *chu* is an important tributary of the Manas river. Initially we thought it to be a large fish-owl, but on observing it through a powerful spotting scope, we identified it as an eagle; the bird flew away before we could get a closer look. After some time it perched again on a tree. This time we identified the bird, to our utter surprise, as the magnificent adult White-tailed Eagle. We observed it for about 20 minutes and also took some still and video photographs, through the spotting scope. The photos, though taken from a distance of at least 250 m, were of good quality. The location was at 27° 38' 20" N and 91° 28' 40" E, and the elevation was 1,900 m above msl.

This is the first record of the White-tailed Eagle from Bumdeling Wildlife Sanctuary, and from eastern Bhutan. Interestingly, this bird is known to move up larger rivers, such as the Brahmaputra and Lohit, but Khulong *chu* is a relatively small river compared to other rivers where the species was recorded earlier. Moreover, it has moved up far north.

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10. SIGHTING OF LARGE NUMBER OF SHORT-TOED EAGLE *CIRCAETUS GALLICUS* AND GREATER ADJUTANT *LEPTOPTILOS DUBIUS* IN KAZIRANGA NATIONAL PARK[1]

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The Short-toed Eagle *Circaetus gallicus* was recorded for the first time in Assam in Dhakuakhana area in 1991 (Choudhury 1991). Prior to that there was no report from north-east India (Ali and Ripley 1987). Subsequently, it was sighted in some more areas like the Nameri National Park (NP), Chakrashila Sanctuary, Kaziranga NP, near Abhoyapuri. Most of the sightings were of single birds. On November 20, 2005, while driving along the patrol roads in Arimora area of Kaziranga NP, accompanied by Dharanidhar Boro, Ranger, I saw a Short-toed Eagle perched on a medium-sized Silk Cotton *Bombax ceiba* tree. Before I could attempt to take a photograph, one more was seen soaring overhead, followed by another three, all singly. We moved towards the road to Borbeel where two were seen perched on a single Silk Cotton tree. We were surprised to see a few more, soaring or flying off from one Silk Cotton to another. The total tally, in the same area, was 11 birds. Most of the birds had typical plumage with grey head and breast, barred underbody and broad sub-terminal tail-band.

On the same day, near the junction of the road to Methonmari on Arimora-Hulalpat road, 50 Greater Adjutants *Leptoptilos dubius* were seen flying from east to west. They were seen flying from west of Arimora and when above the Arimora-Methonmari road, they soared for a while before flying off towards the east and south-east. Up to the point where they took to soar they came like a group, but afterwards split into smaller groups and individuals, and flew downwards (could be observed till tree line blocked view). For Dharanidhar Boro also sighting of such large number of Greater Adjutants in Kaziranga was a first time. The maximum number of Greater Adjutants seen together was 87 resting during the daytime on the banks of the Brahmaputra river off Guwahati city on March 14, 1994 (Choudhury 2000). However, just after the breeding season, more than 80 birds roost at Islampur *kabrstan* (26°10' N, 91°45' E) in the heart of Guwahati city. The Greater Adjutant is listed as endangered because of its very small, declining population (BirdLife International 2004).

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11. THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS*: ARE THEY DISAPPEARING IN KARNATAKA?[1]

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The Great Indian Bustard is a highly endangered bird, and accorded Schedule I protection in the Indian Wildlife (Protection) Act 1972. The bird, common and widespread once in the plains of the Indian peninsula, has become very rare in most of the region due to habitat loss and hunting (Ali and Rahmani 1983). Besides many other states, Karnataka is also known to hold a small population of the Bustard. The Bustard was reported to be widely distributed in the state; however, no evidence of any sightings of the birds was available between 1940 and 1970. Neginhal (1980) reported sightings of a few birds during 1974 at Ranibennur Blackbuck Sanctuary. The birds had been sighted in and around the Sanctuary up to 1982 (Neginhal 1980; Ali and Rahmani 1983; Karanth and Singh 1990). Rahmani and Manakadan (1990) reported the occurrence of Bustard as unconfirmed reports based on personal communication with many researchers in Bijapur, Raichur, Dharwad, Bellary, Chitradurga, Tumkur, Hassan and Mysore, and further they stated that the Bustard is definitely known to exist in Dharwad. They also estimated the Bustard number as 30 to 40 for the state. Neginhal (1997) also reported the Bustard nest and egg from the Ranibennur in 1997. Ghorpade (1996) reported the bird from Hagedal in Gadag district. Bhat *et al.* (2005) based on secondary sources compiled the Bustard status from 1981 to 2005 in Ranibennur Blackbuck Sanctuary, which showed regular sighting of five birds from 1981 to 1997, and highest of 14 birds in 1990; since 1998 the number of birds have drastically gone down in the Sanctuary, however, one bird was reported in 2003.

HNK surveyed the entire state for mammals from 2001 to 2004. During this period, HNK travelled *c.* 30,000 km across different talukas of all districts of the state, and 9,853 km of forest area either on jeep or motorcycle. The authors interviewed 1,401 people, including Forest Department officials, shepherds, villagers and others interested in wildlife. The survey carried out in all regions of Karnataka, including those areas where the Great Indian Bustard does not occur. During the survey HNK also collected information on a few other birds. VM also surveyed the Gadag, Haveri, Koppal, Bellary and Raichur districts during 1999 to 2004 for the Bustards. This note gives an account of the earlier records and recent observations on Bustard sightings by the authors.

During the survey no Bustards were sighted in the drier plains of the entire state. However, the photos of an egg taken in 2002 (Panchalingegowda, ACF, Tumkur) at Sira, Tumkur district, resembles the egg of a Bustard. This is the only possible evidence of occurrence of the Bustard in the southern districts of the state. However, no evidence could be sought for the direct sighting in the southern districts. Even the direct sightings in northern districts are only transitory records (Samad 2006). The forest personnel in Ranibennur Blackbuck Sanctuary have sighted no bustards since 2000, in and around the Sanctuary. However, sighting of a solitary bustard in a patch of *Acacia catechu* adjoining the bustard plots in Ranibennur Blackbuck Sanctuary by the staff was reported to VM on June 06, 2004. Apart from the above sight record, the interview with the local people in the district and around the Ranibennur Blackbuck Sanctuary also revealed no sightings of the Bustard.

VM sighted a solitary bird between Koppal and Gadag, and just 2 km before Bannikoppa station on December 08, 2001, while travelling in a train. Since the train was slow the bird could be easily identified as the Great Indian Bustard. The bird was not shy and tolerated the train, in fact it moved a couple of steps with its typical cocky posture and bent down to feed. The bird was nearly 50 to 60 m from the tracks, in a groundnut field. The bird was sighted at a distance of <1 km where earlier a herd of more than eight blackbuck (*Antilope cervicapra*) were seen.

The above sight records reflect that bustard sightings in the State are infrequent. The situation appears alarming and needs immediate attention. It is crucial to provide and improve the habitat of the bird, especially at Ranibennur Blackbuck Sanctuary, which is known to have good numbers of the bustard.

The recent disappearance of the bird has been attributed to habitat manipulation, i.e. changing the open undulating grassland with little scrub forest into Eucalyptus plantations (Neginhal 1997, 2005). Neginhal (2005) also reported the details of the habitat change in Ranibennur

Blackbuck Sanctuary over a period of one century, and also its impact on different wild animals. Regular monitoring of the bird in a large spatial area is required, and also the monitoring of the habitat, to know more about the population trend.

ACKNOWLEDGEMENTS

We thank the Chief Wildlife Warden and the officials of the Karnataka Forest Department for permission to carry out this study and for assistance in the field.

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12. RECENT RECORDS OF YELLOW-EYED PIGEON *COLUMBA EVERSMANNI* IN RAJASTHAN[1]

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The Yellow-eyed Pigeon *Columba eversmanni* is a rare winter/passage migrant in the Indian subcontinent. It breeds in Central Asia from the southern Aral sea south to north-east Iran and Tien Shan Mountains and northern Afghanistan east to Lake Balkhash and far western China, and winters in southern parts of its breeding range south to Pakistan and north-west India (Gibbs *et al.* 2001).

The species is classified as vulnerable because it has declined rapidly in the past as a result of changing agricultural practices and hunting in its wintering grounds, and possibly habitat loss in its breeding grounds (BirdLife International 2000).

HSS was fascinated by the species after reading an article in the *Hornbill* (Singh 1980). However, it was only after his visit to Harike in Punjab with Per Undeland (PU) that he really started looking for the species in Rajasthan. Incidentally, PU highlighted the presence of large flocks at Harike by writing about the species (Undeland 1997) and reporting to the Oriental Bird Club (Crosby 1995; Robson 1996, 1997).

On February 17, 2001 while censusing vultures, HSS and Rishad Naoroji flushed *c.*70 birds at Camel Breeding Farm, Jor-Bir, Bikaner (28° 04' N, 73° 23' E) in the cold morning from two-three *Salvadora persica* trees. The birds were quite concealed in the canopy of the trees that they almost missed seeing them. The pigeons burst out of the trees when they unknowingly drove their jeep too close to them. Although the pigeons rapidly flew away there was no mistaking their diagnostic white rumps. After flying about for one or two minutes they settled on about four *Salvadora persica* trees.

Again at Jor-Bir *c.* 100 birds were observed foraging on the ground on December 18, 2001. The flock was extremely wary and after flying away settled on three or four *Salvadora persica* trees. Once settled they were lost in the canopy of the trees; only those birds which perched on the tree tops were visible.

Incidentally, R.G. Sonia, a senior officer of the Forest Department of Rajasthan, presented a set of photographs of the species to HSS. While posted at Bikaner, he photographed a mixed flock of about ten Rock Pigeons *Columba livia*, and fifteen Yellow-eyed Pigeons *C. eversmanni* at Jor-Bir on November 11, 1995 when they came to drink water at a pool.

As an aside, this open area with scattered *Salvadora persica*, *Prosopis cineraria* and *Zizyphus mauritiana* has

been attracting vultures in large numbers since 1998. The area is used by the municipality of Bikaner city for dumping carcasses (mostly cattle).

SK met with the species near Rupawas, Pali in the first week of February, 1998. About 60 birds were foraging on the ground and when disturbed they flew up on the trees "not like our pigeons (*Columba livia*) but like buntings." After the disturbance was over they came down again to the ground to feed.

On April 23, 1998 between 1100-1500 hours, at the border outpost of Kheruwala, Ganganagar, SK counted *c.* 100 birds on the "border lighting posts of the fence" spread over an area of several kilometres in groups of four or five.

There are two more recent records from Rajasthan. A local *shikari* saw "*c.* 60 *salara*" (*Columba eversmanni*) in January 2003 on the Gang Canal near Sri Ganganagar (Gurdip Singh pers. comm.).Three birds were seen in the Kadam Kunj area of Keoladeo National Park, Bharatpur first on January 4, 1999 and then during the first week of March. Most of the time they were seen on a Kadamba *Anthocephalus cadamba* (Vibhu Prakash *in litt.* 2000). Incidentally, there is only one old record of the species from Bharatpur. Abdulali (1970) during a three day visit to Bharatpur in October 1951 saw the species "in pairs and parties of 15/20 in open"

While posted at Tonk, HSS was informed by Aziz-ul-Haq of the erstwhile Tonk family that up to 1970s the birds were sporadically shot during winter months in Tonk district. The species was so well recognized that it also had a local name. The local *shikaris* used to call it *pitkula*.

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13. ON THE SIGHTING OF THE LESSER COUCAL *CENTROPUS BENGALENSIS* IN THE ANDAMAN & NICOBAR ISLANDS[1]

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During a recent bird watching program in the Andaman Islands a Coucal that fitted the description of the Lesser Coucal *Centropus bengalensis*, a previously unrecorded species in the Islands, was observed on April 5, 2004 close to No. 6 at Havelock Island. The bird was subsequently re-sighted the next day very briefly early in the morning. The bird that we sighted was smaller than the common Andaman Coucal *Centropus andamanensis*, and the Greater Coucal *Centropus sinensis* found commonly across India. It was black except for deep rusty brown/chestnut wings, with a burst of flight, typical of coucals observed as it crossed the road. It allowed us to stop and confirm our sighting, however, a photograph was not possible within the short span of observation and also due to the heavy brush of the roadside where it had perched.

The only species of *Centropus* that have been recorded from the Andaman & Nicobar Islands include the endemic Andaman Coucal *Centropus andamanensis* (Grimmett *et al.* 1999), and sightings of a coucal species on Great Nicobar Island (Sivakumar 2000), which was possibly the Lesser Coucal (R. Sankaran pers. comm.). On a subsequent field visit in May 2004 to Little Andaman Island, a bird the size of the Andaman Coucal, but of the coloration of the mainland coucal, was spotted in the beach forest of South Bay (Totibue), Little Andaman Island.

Coucals, possibly other than the Andaman Coucal, have now been sighted at three widely separate locations in the islands. More sightings and other information are required to clarify whether the species is a vagrant or has colonized these islands. The Lesser Coucal is recorded, so far, from the Himalayan, north-eastern region and south-western regions of India, Bangladesh and south-eastern Asia, but not from the Islands in the Bay of Bengal. If this species is confirmed to be a resident of the archipelago it will add to the avifaunal diversity of the Islands and the geographic distribution of the species itself. The other possibility includes colour variation within the species of Andaman Coucal ranging from its more frequently encountered colour of beige body with chestnut brown wings to the darker versions as described in this note.

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14. SIGHTING OF STOLICZKA'S BUSHCHAT *SAXICOLA MACRORHYNCHUS* IN PUNE DISTRICT, MAHARASHTRA, WESTERN INDIA[1]

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Stoliczka's Bushchat *Saxicola macrorhynchus* (Family: Muscicapidae, Subfamily: Turdinae) is resident and rare locally, but not uncommon in some areas. It is confined to desert parts of Rajasthan and Kutch region of Gujarat. It occurs in sandy desert plains and scattered bushes. In this note I report sighting of this species from Pune district, Maharashtra, western India.

On December 22, 2004, a team of bird-watchers consisting of Advait Godbole, Parag Deshpande, Aditya Joshi, Hrishikesh Joshi and I, visited Varvand. This is a wetland surrounded by open, sparse scrub and stony wasteland, situated on the Pune-Solapur highway *c.* 60 km from Pune city. At 1500 hrs, we spotted a bird perched on a bush. The following distinguishing characters helped to identify the bird as Stoliczka's Bushchat: a distinct buffy-white supercilium, black bill, buffy underparts with white upper breast and throat, white patch on the inner greater coverts, pale rump and white outer tail feathers. In some of the photographs we took, there is an indication of a small white patch on the inner greater coverts, suggesting that this was a first winter male.

This constitutes the first record of the species from Pune district, *c.* 600 km south of its usual range. The closest records, by Krys Kazmierczak, of the species are from Velavadar National Park, Gujarat. Humayun Abdulali's CHECKLIST OF BIRDS OF MAHARASHTRA (1973, BNHS) does not list this species. This observation, therefore, is significant, but the reason for this southern dispersal of the species is still unknown.

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to Krys Kazmierczak, Bill Harvey and Asad R. Rahmani for their guidance and comments.

15. STATUS OF MUGGER *CROCODYLUS PALUSTRIS* IN SIMILIPAL TIGER RESERVE, ORISSA, INDIA[1]

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Of the 21 species of crocodilians that are found in the warm subtropical and tropical regions of the world, three namely Gharial *Gavialis gangeticus*, the Saltwater or Estuarine Crocodile *Crocodylus porosus* and the Mugger *Crocodylus*

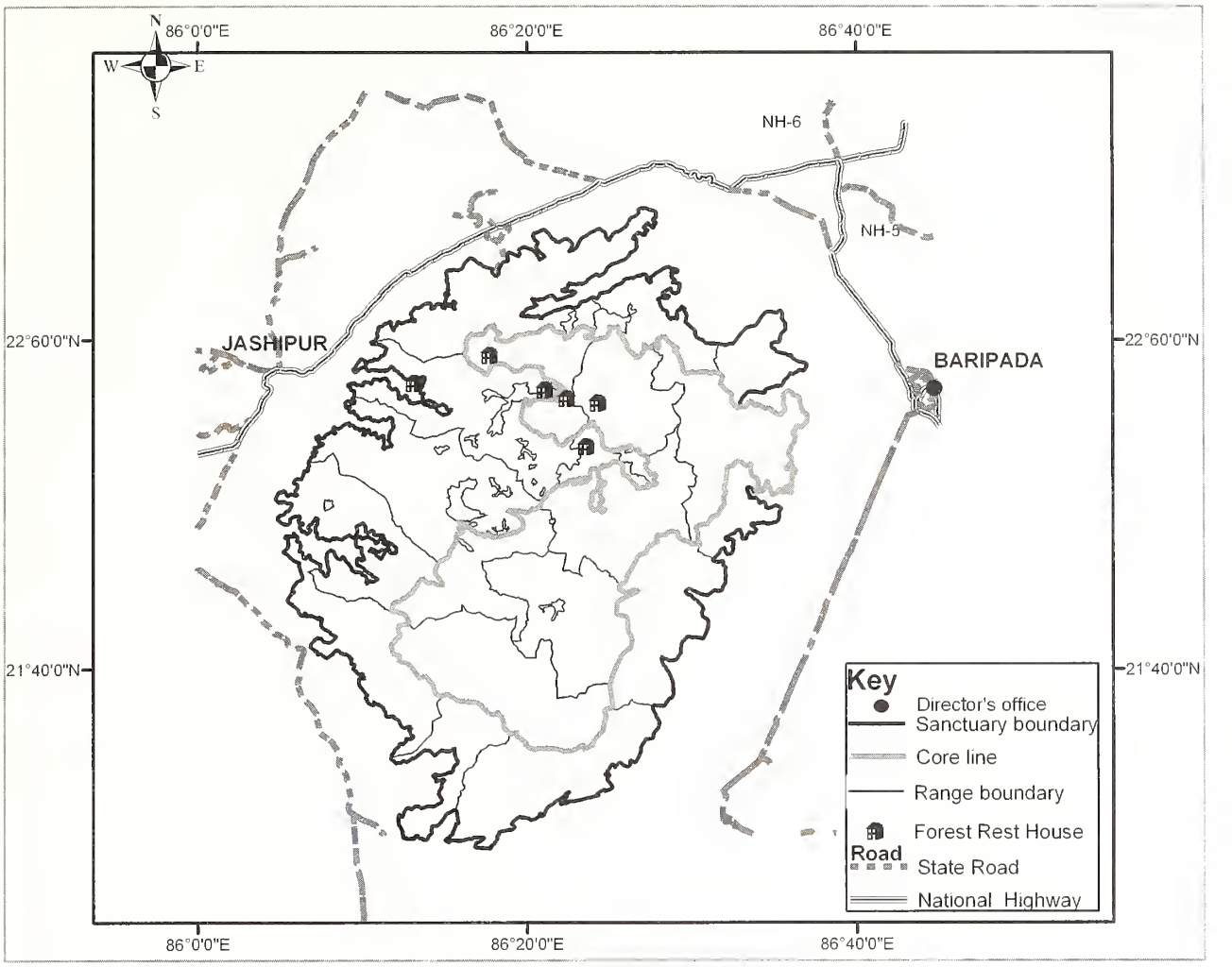

Fig. 1: Location map of the study area (Similipal Tiger Reserve)

palustris, occur in the Indian subcontinent (Singh 1999). All the three occur in the state of Orissa; the Gharial is found in the Mahanadi, the Saltwater Crocodile is found in Bhitarkanika Sanctuary and the Mugger is found in the river systems of the Similipal Tiger Reserve.

Results of a survey for the Mugger conducted in November-December 1979 indicate that the Mugger had virtually become extinct in the area of the Similipal Tiger Reserve (Anon. 1999). Although the reasons for extinction of the Mugger from the Similipal Tiger Reserve were not clear, Anon. (1999) cites adverse factors like (i) fishing using explosives and nylon nets, (ii) use of DDT and other insecticides with an intention to control malaria, (iii) fire on the river banks that serve as nesting sites, and (iv) natural effects of activities such as predation, and/or exhumation of nests by wild boars and monitor lizards.

In 1979, the Mugger Management Project was started in Similipal at Ramatirtha, near Jashipur, with the aim of maintaining a viable population of the Mugger in Similipal, conducting management-oriented research, and providing muggers for re-stocking elsewhere, under financial support from UNDP, FAO, Government of India and Government of Orissa. Of the initial stock of 150 young muggers brought from Tamil Nadu, six were retained for captive breeding at Ramatirtha. Over the years, 788 crocodiles have been released into the river systems of Similipal (Table 1). The present study reveals the status of the Mugger in the various river systems of Similipal Tiger Reserve.

Study area

Similipal is a densely forested hill-range in the heart of the district of Mayurbhanj in Orissa, lying close to the easternmost end of the Eastern Ghats. Located in the Mahanadian Biogeographical Region and within the biotic province of the Chhotanagpur Plateau, it spreads over an area of 2,750 sq. km. The whole of the Similipal hill-range falls under the Similipal Tiger Reserve (20° 17' - 22° 10' N and 85° 57' - 86° 47' E; Fig. 1). Because of the uniqueness of its flora,

Table 1: Release figure of the Mugger into the river systems of the Similipal Tiger Reserve

Year	Number released
1981	60
1985	18
1986	42
1987	39
1988	12
1989	25
1990	42
1991	82
1992	90
1994	32
1995	108
1996	70
1998	50
2000	89
2002	29
2003	-
Total	788

fauna, forests, landscape and tribes, Similipal was declared a Biosphere Reserve in 1994. Its highest mountain is the peak of Khairiburu, 1,168 m above msl. Similipal is the richest watershed in Orissa, giving rise to many perennial rivers like the Budhabalanga, Khadkei, Khairi, Bhandan, West Deo, Salandi, East Deo, Sanjo and Palpala.

Methodology

A survey of the Mugger in Similipal was conducted during January 24 - February 18, 1999, March 7 - 19, 2000, February 11 - 17, 2003 and March 9 - 16, 2004 to ascertain the status of the Mugger inside the Similipal Tiger Reserve (TR). For this purpose, the entire survey team was divided into two groups, namely Team A and Team B, and different river systems were allotted to these teams. They surveyed the river bank on foot. During the survey, direct sighting as well as indirect evidence such as tunnels, basking places, scute marks on the ground were taken into account. The different routes surveyed during the period are shown in Table 2. Body length was measured by ocular estimation during direct sighting. From indirect evidence, body length was measured from the tracks of the hind paw mark and also from the tail mark – body length is equal to approximately 14 times paw length and approximately 65 times the maximum distance between the two lines created because of the movement of the tail (Singh 2000).

The numbers counted in the rivers of West Deo, Khadkei, Budhabalanga, Khairi and East Deo are given in Table 3. The size/length-wise distribution of the Mugger as per the 2004 census is given in Table 4.

Table 2: Routes surveyed in the river systems of Similipal TR

Sl. No.	River system	Route
1	Budhabalanga	1) Budhabalanga village to Jambu bridge
		2) Jambu bridge to Barehipani fall head
		3) Barehipani fall head to Bhatunia
		4) Bhatunia to Majhigaon
2	East Deo	5) Sarua pool
3	Khairi	6) Jenabil to Ransa
		7) Ransa to Kabataghai
4	West Deo	8) Debasthali to Kandadhenu
		9) Kandadhenu to Jalchinda
		10) Patabil to Upper Baraha Kamuda (UBK)
		11) UBK to Manda Darah
5	Khadkei	12) Khadkei to Baunskhal
		13) Baunskhal to Soriopal
		14) Haldia down stream
		15) Panasia reservoir

Table 3: Number of Muggers sighted in the river systems of Similipal Tiger Reserve from 1999-2004

River systems	1999	2000	2003	2004
West Deo	34	58	30	42
East Deo	5	1	1	5
Khairi	17	26	15	20
Budhabalanga	8	10	6	9
Khadkei	7	2	0	7
Total	71	97	52	83

Table 4: Size/Length-wise Distribution of Muggers in the river systems of Similipal Tiger Reserve as per 2004 census

River systems	<1m	1-1.5 m	1.5-2.0 m	>2.0 m
West Deo	14	8	16	4
East Deo	1	4	0	0
Budhabalanga	0	2	5	2
Khairi	5	3	10	2
Khadkei	2	3	2	0
Total	22	20	33	8

The Mugger is the most adaptable of the three crocodilians and has been encountered up to 400 m in clear hill streams, sewage treatment ponds and cold deep rivers in the Himalayan foot hills (Whitaker and Andrews 2003). In the Similipal Tiger Reserve, they have been seen at an elevation of 850 m.

From the above results, it was found that Mugger sighting was higher in the West Deo compared to other river systems (Fig. 2), as it is confined to the core area of the Similipal Tiger Reserve where there is reduced anthropogenic

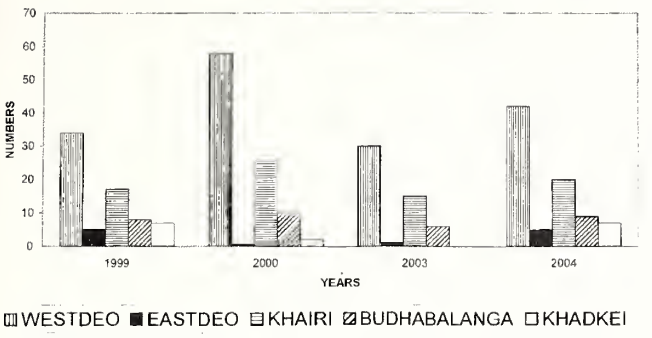

Fig. 2: Distribution of Muggers in the river systems of Similipal Tiger Reserve

disturbance, biotic interference, the presence of *darahs* (deep water area), and adequate basking sites. Though East Deo is also situated in the core area, there are fewer *darahs* and basking places. In Budhabalanga, the riverbank is steep and rocky, the availability of basking places lower, and biotic interference greater. In Khairi, the population of the Mugger is higher from Jenabil to Jadi *darah* in the Jenabil to Ransa route. Here, their number is lower in comparison to the West Deo as the river bed is rocky, providing a smaller area for the basking. But a detailed systematic study has to be made seasonally in order to study the seasonal behaviour and the ecology of the Mugger in the Similipal Tiger Reserve because the crocodile plays the vital ecological role of a master predator in the aquatic habitat where it lives (Whitaker and Andrews 2003).

Moreover, sightings were more in 2000 and 2004 as the census was carried out in March. During this time, the river bank area was more exposed and the temperature was 20° - 30° C, which was suitable for Mugger sighting. The release figure (Table 1) reveals that the population inside Similipal is not related to the release of the Mugger in the wild.

From Table 4 it is seen that during the 2004 census, 33 Muggers within a body length of 1.5 to 2.0 m, and 8 Muggers of more than 2 m body length indicate that 47% are adult. In Tamil Nadu, the wild mugger population is 465 with an adult population of 52% (Andrews 1999), and in Gujarat, the population is 492, with an adult population of 88% (Vijayakumar *et al.* 1990). In Similipal, the recent survey shows that the population is 83 with an adult population of 47%. However, the census shows that the mugger population is stable inside the Similipal Tiger Reserve.

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16. OBSERVATIONS ON BURROWS DUG BY MUGGER CROCODILES (*CROCODYLUS PALUSTRIS*) IN BUNDALA NATIONAL PARK, SRI LANKA[1]

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During a brief visit to Bundala National Park (Fig. 1), May 7-10, 2002, the authors caught, measured and sexed two mugger crocodiles in burrows. These burrows were measured and mapped, and temperatures recorded, both inside and outside the burrows, for 48 hrs. A total of 38 burrows were seen, which ranged from 3.05 m to over 6.0 m in length.

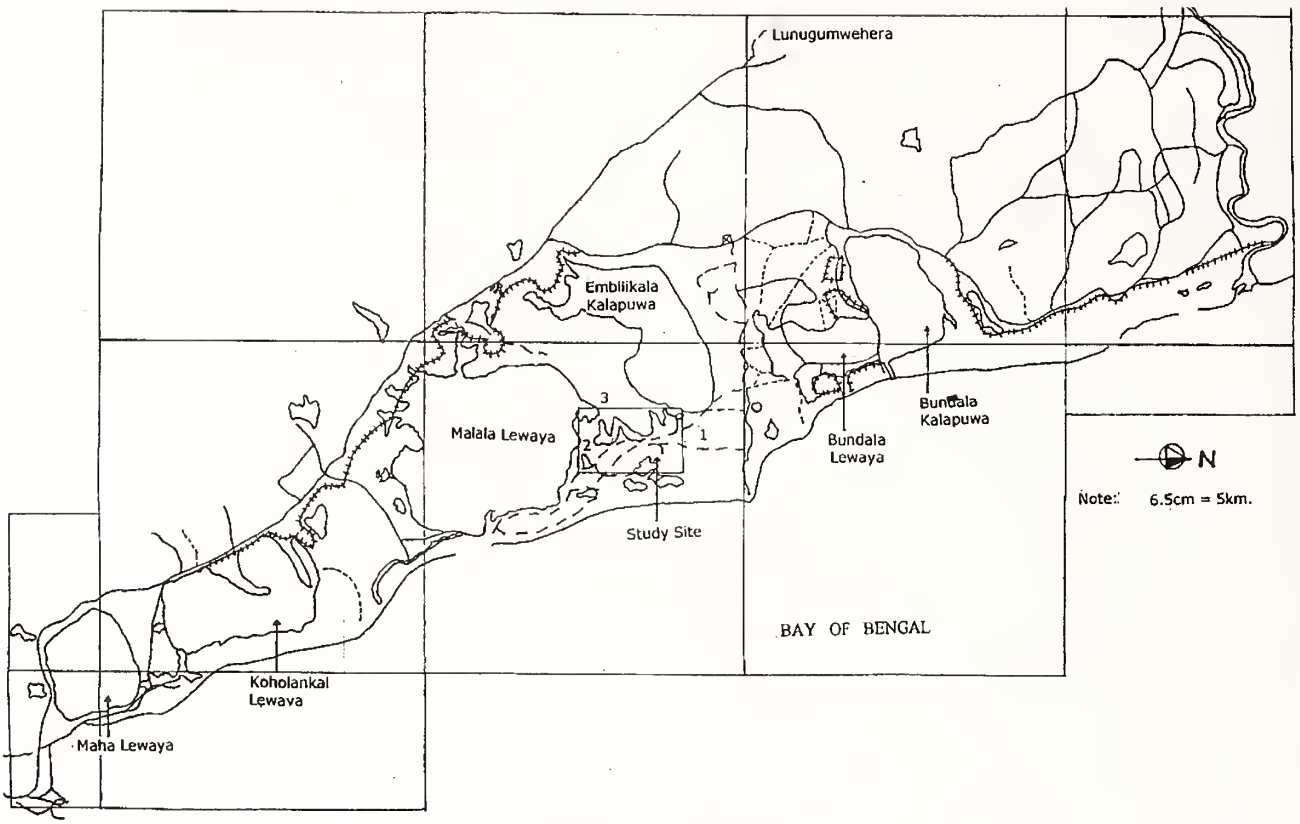

Fig. 1: Bundala National Park, Sri Lanka

Entrances were 45.72 cm to 137.16 cm in width and 27.94 cm to 60.96 cm in height. Temperatures outside the burrows fluctuated from 28° C to 46° C while burrow interiors remained virtually static at 29° C.

It is likely that most of the world's crocodilians dig burrows or tunnels to hide in and to tide over extreme weather conditions (Guggisberg 1972; Steel 1989; Chen *et al.* 1990). Crocodilian species found in the tropics presumably rely on burrows to survive the effects of drought and extreme heat; however, the two species of alligator (*A. misissipiensis* and *A. sinensis*) that range above 30° N where temperatures fall below freezing, dig and utilize burrows as refuges from cold winter temperatures. The mugger crocodile (*Crocodylus palustris*) found throughout the Indian subcontinent, as well as Sri Lanka, is a noted burrow digger. This species presumably utilizes the burrows as an effective refuge from the hot daytime ambient temperatures found in Bundala, Sri Lanka, the southernmost range of *C. palustris*. Crocodilians have an optimum body temperature of 30-35° C, and if subjected to temperatures below 5° or above 38° C for extended periods, they are in danger of dying (Lang 1987). Burrows may play a critical role in the survival of crocodiles living in harsh environments, such as southern Sri Lanka.

There are numerous references to mugger burrows in the literature, a few of which follow: Deraniyagala (1936) describes the U-shaped mugger burrow found in riverbanks in Sri Lanka often under the roots of the typical riparian tree giant, *Terminalia arjuna*. McCann (1940) mentions mugger burrows at the Sind salt lakes (now Pakistan). Whitaker (1977) describes finding sixteen mugger burrows in the Hiran Lake, Gir Lion Sanctuary in Gujarat with "flattened, oval entrance" averaging 80 cm width and 4 to 5 m deep. There was a croc in nearly every tunnel at the end of May 1975 and outside temperatures were reaching 46° C in the shade. Whitaker and Whitaker (1984) referred to mugger burrows in Sri Lanka, Gujarat, South India and noted that yearling, subadult and adult mugger all dig burrows. They briefly describe the tunnelling, the crocodile using its front feet to dig and push earth back to the hind feet which scrape the dirt back to where the tail propels it away into the water. Gupta and Srihari (1990) studied mugger burrows at Bhorsaindan Sanctuary, Haryana and found that burrow utilization was greater in winter months when temperatures dropped to 11° C. Shekar (1993) reported two to six muggers in the same burrow in winter months at this Sanctuary. Vijaykumar (1997) enumerated 114 mugger burrows in different parts of Gujarat. Most burrows were from 0.6 m to 2.6 m in depth, though two in Gir Sanctuary were over 6 m. He mentions that the temperature inside a 3 m burrow remained constant at 19.2 to 19.8° C while the outside temperature fluctuated from 12 to 43° C. He gives no date but

judging from the temperature and the fact that most burrows were empty it was probably in February, before the serious dry season sets in.

Methods

With the permission of the Department of Wildlife Conservation, Sri Lanka and help from the Bundala National Park Warden and staff we visited three main burrow sites by a 4-wheel drive vehicle and on foot (Fig. 2). Several burrows were measured from the burrow mouth, and two of the larger ones were entered and mapped. These two large tunnels contained crocodiles which were caught, measured, sexed, marked and released on site. Two other free swimming crocodiles were caught with swivel-lock wire nooses to demonstrate safe capture, sexing, marking and release techniques to the NP staff. Data loggers (Stowaway Tidbit loggers, Onset Computer Corporation) recorded temperature simultaneously at 30-minute intervals for 48 hours and were placed inside and outside burrows and in the water close to the tunnel mouths. Sexing was done by digital probing of the cloaca.

Results

Site 1: Local name: Sudugala

Description: raised 50 m long embankment of sand and black soil about a metre above present water level (it had rained a few days earlier), facing southwest. Water channel in front of embankment 12 m wide and 25-50 cm deep, fresh. Vegetation: *Prosopis juliflora* (mesquite), *Salvadora persica*, reeds (dry now) and small bushes.

Mapping of sample burrow (No. 1 at North end)

	Height (cm)	Width (cm)
Entrance	37.5	70.0 (2.5 m from water's edge)
2 metres in	32.5	90.0
4 metres in	37.0	105.0 (chamber)

Burrows: Five burrows, three were occupied and two crocodiles about 2 m length were observed in the adjacent water. Burrow entrances ranged from 25-40 cm in height and 35-70 cm in width. Two of the burrows were at water level, three were dry.

Crocodile pulled out of this burrow was a 2.70 m female missing about 15 cm of its tail end and clipped by us on the 6th dorsal caudal whorl on the left.

Crocodile caught in adjacent water was also a female, 2.40 m in length and clipped on the 8th dorsal caudal whorl on left.

Site 2: Local Name: Campsite

Description: Raised 75 m long embankment of sand and black soil 2 m above present water level facing north-west. Water and channel 20 m wide and 1 to 1.5 m deep, fresh. Vegetation: same as Site 1 with *Phoenix* sp. (dwarf date palms).

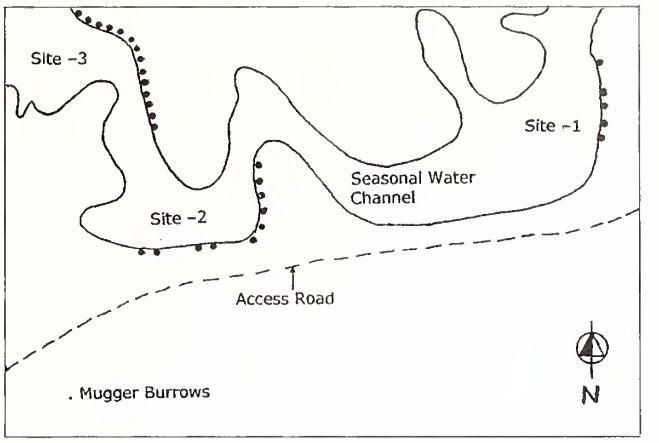

Fig. 2: Detail of study site, Bundala National Park

Burrows: 10 burrows, 1 occupied plus 4 crocodiles 1.5 to 2.5 m in the adjacent water. Burrow entrances were mostly above present water line and ranged from 20-40 cm in height and 28-135 cm in width. Depth of one was more than 6 m.

Crocodile pulled out of this burrow was a 2.35 m female with a mangled 4th single caudal whorl (for I.D.). Temperature loggers were placed in the water and on the substrate (unshaded) outside the burrow and at three depths inside the burrow. Results are given in Figs 4 and 5.

Site 3: Local Name: Campsite Tuduna (point)

Mapping of sample burrow
(No. 2 from North end under *Phoenix* palm – Fig. 3)

	Height (cm)	Width (cm)
Entrance	40.0	135.0
2 metres in	42.0	77.5
3 metres in	27.5	72.5
5 metres in (chamber)	82.0	114.0 (partly caved in)

Description: Raised 160 m embankment of sand and dark soil 1.5 to 2 m above present water level facing west – south-west. Water channel about 25 m wide and 1 m deep, slightly brackish. Vegetation: mainly *Prosopis* and small bushes.

Burrows: 23 burrows, 3 occupied, 2 crocodiles *c.* 2 m in water. All entrances were above the present water level. Entrance height ranged from 23 cm to 60 cm, widths from 28 cm to 77 cm. Burrow depths 3-5 m.

Other animal life observed in the burrows: Gecko, centipedes, mosquitoes, cockroaches, and ants.

Discussion

Mugger dig burrows of sometimes more than 6.0 m in

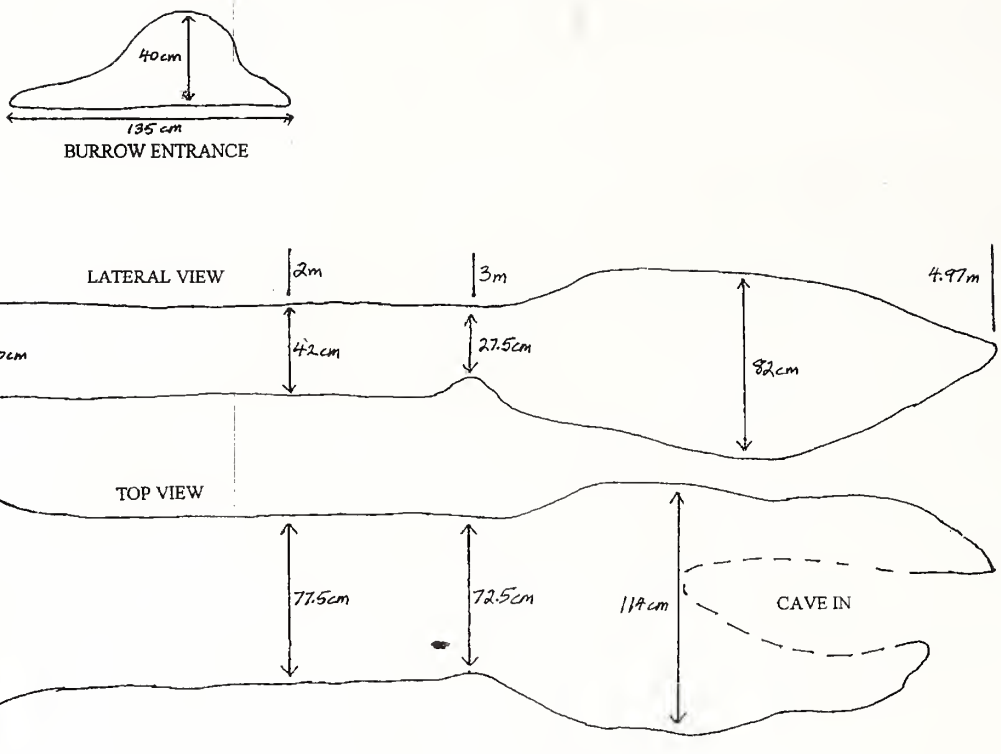

Fig. 3: Burrow 2 (site 2) interior map (not to scale)

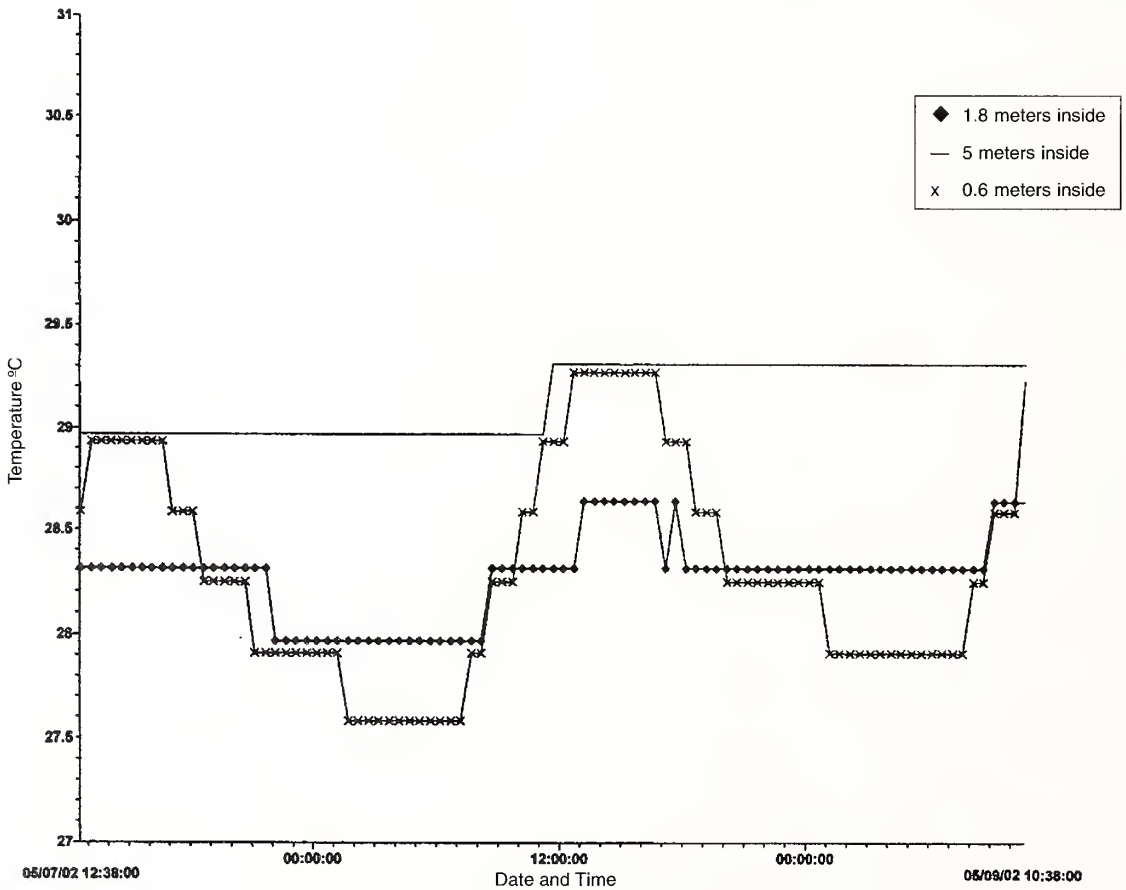

Fig. 4: Burrow 2 (site 2) temperature readings inside burrow

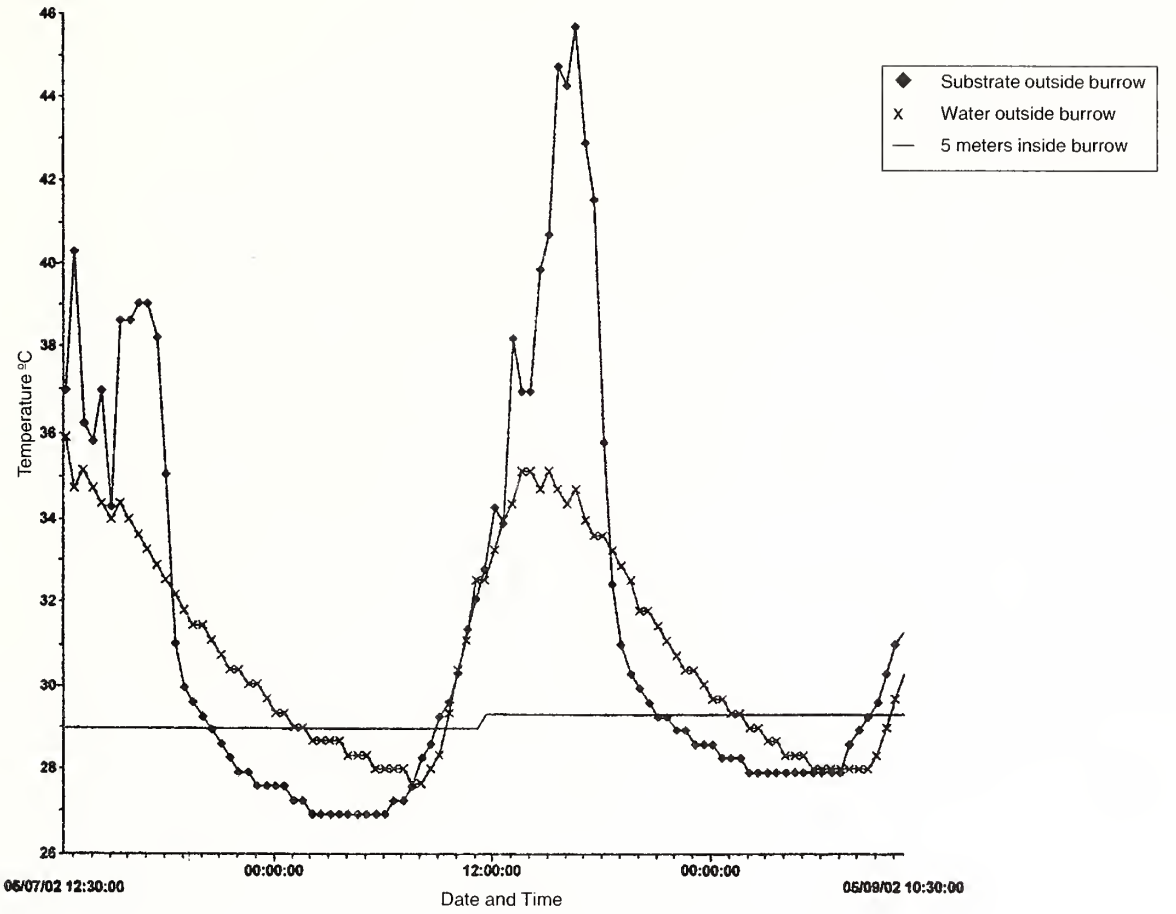

Fig. 5: Burrow 2 (site 2) bihourly temperature readings

length to escape the heat and desiccation of sometimes very long and harsh dry seasons in South Asia. The burrows observed in this study were clean with no smell and with varying degrees of dampness. Few of them were occupied which is likely to be because of the recent rains and lower temperatures. Most burrows showed signs of recent occupation and some of recent digging. Invariably the deeper burrows sloped downward at the end, with a larger chamber up to double the width of the tunnel for the crocodile to turn around and comfortably lie in. Very often deeper burrows turned so that the end was not visible. One characteristic of most tunnel entrances is the raised central mound of earth or sand. This is formed as the crocodile enters the tunnel and digs with front and hind limbs, as it goes in. Digging seems to be a continuous process and it is likely that some burrows took several years to dig and may be in use for decades or more. It is surmised that tunnels are used as occasional refuges at this time of year with the more permanent residents moving in at the July-October period of peak hot weather. Several observers (Shekar 1993; Vijaykumar 1997; Whitaker *in litt.*) noted that female mugger will lay their eggs at the mouth of their tunnel, a strategy that can optimize nest and hatchling survival.

The graphs showing the data from the loggers (Figs 4 and 5) are self-explanatory. The two things that stand out are (a) the amazing consistency of temperatures deep within the burrows (not coincidentally, optimum for a crocodilian) and (b) a sudden small rise in temperature near midnight in one burrow, which could have been the entry of a crocodile.

A behavioural observation of considerable interest is that when we approached adult muggers in shallow water they would first attempt to swim away, but failing to find deep water they would leave the water to enter a nearby tunnel or if no tunnel was present they would simply walk up into the forest for shelter, more like a big lizard than a crocodile! In one case a large female got herself entangled in some bushes and we were able to ascertain her sex without catching or restraining her.

Some burrows were observed to have unstable roofs in danger of collapse. Numerous collapsed burrows were seen (mostly old) probably due to heavy rains. One of the authors (Pradeep) has counted over 90 mugger burrows in

Bundala NP and another (Whitaker) enumerated burrows in the Menik Ganga (Yala NP) and Lunugumvehera NP. These observations and the results of this small study point to a fascinating and important behaviour by mugger which deserves systematic study. A comprehensive investigation focussing on the role of burrows in relation to the thermal ecology of crocodilians is sorely lacking and Sri Lanka offers a unique opportunity. The mugger cannot survive extended dry seasons without being able to regulate its temperature within safe limits. In a hot, dry area like Bundala their burrows are a vital refuge. Protection of the embankments in the Park is important for the long-term conservation of the species.

ACKNOWLEDGEMENTS

We wish to thank the Director, Department of Wildlife Conservation, Sri Lanka, the Park Warden and staff at Bundala National Park for their help in making this study possible. Thanks are also due to Harry V. Andrews for his inputs.

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17. A REPORT OF *GECKOELLA NEBULOSA* (BEDDOME, 1870) FROM SEONI DISTRICT, MADHYA PRADESH[1]

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On October 30, 2003 a freshly killed *Geckoella nebulosa* (Das 2003) was seen near a pile of rocks, close to a road near Seoni (22.06° N, 79.35° E), just outside Pench National Park.

The specimen was collected and deposited in the collections of the Bombay Natural History Society (Regn. No.: BNHS 1598). The forest type in Seoni district is Tropical Dry Deciduous and Tropical Moist Deciduous, largely dominated by *Tectona grandis* (Champion and Seth 1968). The area in which the gecko was found was a shady, forested patch, with little undergrowth, dominated by *Tectona grandis*.

The lizard measured 37.3 mm snout-vent length, and 27.2 mm tail length. The specimen agrees with Smith's (1935) description – 10 supralabials on both sides, 38 midventrals, back with small granular scales interspersed with numerous larger rounded tubercles. A notable discrepancy is that the specimen has 8 infralabials on each side, as against 10 in Smith (1935). The coloration is also the same as Smith (1935), except the tail tip was bright orange.

Other reptiles seen in the same area were *Sitana ponticeriana*, *Psammophilus blanfordanus*, *Hemidactylus brookii*, *Calotes versicolour*, *Mabuya carinata* (visual identification) and a shed skin *of Ptyas nucosus.*

This gecko was originally described as *Gymnodactylus nebulosa* from Golconda Hills (Andhra Pradesh) by Beddome in 1870. Further distributional records are as follows: Nelambo, South India (= Andhra Pradesh): Annandale (1913), Smith (1935), Tikader and Sharma (1992); Gorge Hills, Godavery and Russelconda in Andhra Pradesh: Smith (1935), Tikader and Sharma (1992); Mandla district, Madhya Pradesh (adjacent to Seoni district): Sharma (1976), Tikader and Sharma (1992); Kerala (Nilambur, Malappuram district) and Tamil Nadu (Saidapet district): Tikader and Sharma (1992); Koraput district, Orissa: Sanyal (1993); Puri district, Orissa: Dutta (1997). Das (2002) gives the distribution of this species from Puri and Koraput district in Orissa, to Gorge, Golconda and other isolated hills in Andhra Pradesh. The University of Michigan

Museum of Zoology has a skeletal preparation, UMMZ 127632, from Kharagpur, West Bengal (Gregory Schneider pers. comm.).

The report of this gecko from the Seoni district of southern Madhya Pradesh is the second report of this species from the state, and the first from Seoni district. The known distribution of this poorly studied gecko is interesting – being found in the Eastern Ghats of Andhra Pradesh, Orissa and Tamil Nadu; up to West Bengal; as well as in the foothills of the Satpuras in Madhya Pradesh. The distribution of *Geckoella nebulosa* appears to be in the central and eastern parts of India, thus the report from Kerala (Tikader and Sharma 1992) needs confirmation.

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I would like to thank V. Giri for encouraging me to publish this note, and V. Giri and A. Captain for help with the draft.

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18. REDISCOVERY OF THE MISSING SYNTYPES OF *MABUYA NAGARJUNI* SHARMA 1969 (REPTILIA: SCINCIDAE) IN THE COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA[1]

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Sharma (1969) described *Mabuya nagarjuni* based on specimens collected from Vijaypuri South, Andhra Pradesh, near the right-bank of the River Krishna, 16°35' N, 79°28' E, *ca.* 152 m above msl. The original description did not formally designate a holotype, for which reason, all four specimens from the original type series need to be considered syntypes. The type series, which was collected on August 23, 1962 by B. Nath and I.N. Maligi, was deposited in the collection of the Zoological Survey of India (ZSI), Kolkata. This nominal species, along with other Asian members of the Scincidae once assigned to the genus *Mabuya*, was transferred to the genus *Eutropis*, in support of long-separated evolutionary lineages, representing distinct monophyletic radiations of the South American, Asian, Afro-Madagasy and Cape Verdian groups (Mausfeld *et al.* 2002), and the new name combination should be *Eutropis nagarjuni* (Sharma 1969).

Das *et al.* (1998) and Das and Gayen (2004) listed the reptile types in the ZSI. In the former publication, two syntypes (ZSI 21170 and ZSI 21171) were mentioned as being extant, the remaining two syntypes reported as 'untraceable' in the collection. The type register also acknowledges the loss. The purpose of this communication is to announce the rediscovery of the two lost syntypes of *Mabuya nagarjuni* Sharma 1969, in the collection of the ZSI.

On July 29, 2003, while examining the types and additional material of *Mabuya nagarjuni* in the ZSI, in order to compare with new collection made in the vicinity of the type locality (Srinivasulu *et al.* 2005), the first author found two juveniles of the species stored along with other species of *Eutropis*. General coloration and pholidosis matched the pattern reported for this species, and that described by Sharma (1969, 1971). The accompanying label, bearing the number ZSI 21172, carries the same information as that on the labels of the known syntypes (ZSI 21170 and ZSI 21171), except, unlike the two adult female specimens, both the rediscovered specimens were marked 'unsexed'.

Both syntypes being reported here had damaged tails — the smaller individual lack a tail (detached tail not traced), while the larger one had a broken tail (tail incompletely detached from body and broken medially). The recovered syntypes were stored

in a new bottle and shifted to the type collection.

ACKNOWLEDGEMENTS

The authors thank J.R.B. Alfred, former Director, ZSI, for permission and facilities to work in the collection, and S.K. Chanda, former Officer-in-Charge and N.C. Gayen, former Senior Zoological Assistant, Reptilia Section, ZSI, for curatorial support. The first author acknowledges Council for Scientific and Industrial Research, New Delhi for a research grant.

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19. RANGE EXTENSION OF *CHIRIXALUS SIMUS* ANNANDALE 1915 (ANURA: RHACOPHORIDAE)[1]

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Chirixalus simus was described by Nelson Annandale (1915) from a single specimen collected by S.W. Kemp in 1911 from Mangaldai in the Darrang district of Assam. The species remained elusive for the next 85 years till it was rediscovered simultaneously from the Orang National Park in the Darrang district of Assam, and from Rajpur (6 km south of Kolkata) in the South 24 Parganas district of West Bengal (Deuti *et al.* 2000).

During a field study organized by Nature's Foster, a Wildlife NGO, on August 3, 2003, the first author collected a male specimen of the species at 1030 hrs, from a small waterhole adjacent to an agricultural field at Kakoijana Reserve Forest, 15 km east of Bongaigaon town in the Bongaigaon district of western Assam. It was sitting on the stalk of an aroid *Colocasia esculenta* (L). Schott *c.* 22 cm above the ground. No other species were found at the site. During this comprehensive herpetological survey, a degraded foam-nest of the species was observed at the same site, on a grass stalk (*Cyperus* spp.) 8 cm above the stagnant water in the crop field. Some other amphibians found at the Kakoijana Reserve Forest were *Bufo melanostictus* (Bufonidae), *Fejervarya limnocharis* (Ranidae), *Microhyla ornata, Kaloula taprobanica* (Microhylidae) and *Polypedates maculates* (Rhacophoridae).

The morphometric measurements of the collected specimen are: snout-vent length: 21.65 mm, head length: 6.85 mm, head width: 6.90 mm, snout length: 3.85 mm, eye diameter: 3.65 mm, inter-orbital length: 3.25 mm, tympanum diameter: 1.60 mm, humerus length: 3.60 mm, total fore limb length: 13.35 mm, femur length: 11.15 mm, tibia length: 11.80 mm, total hind limb length: 36.75 mm.

The specimen was deposited at the National Zoological Collections of the Amphibia section of the Zoological Survey of India, Kolkata (Regn. No. ZSI A9852). This collection extends the known distribution of the species by 140 km to the west in Assam. Kakoijana Reserve Forest is already known to harbour a small population of about 100 Golden Langurs (*Trachypithecus geei*), besides a wide range of birds, reptiles, fishes and invertebrates. The discovery of this little-known tree frog from this RF strengthens the need for its protection.

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and the Honarary Wildlife Warden for encouragement; S.N. Sen, J. Chakraborty, G. Ghosh of Nature's Foster for their support, and M.S. Ravichandran of Zoological Survey of India, Kolkata for registering the specimen.

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20. SEXUAL DIMORPHISM IN THE CYPRINID FISH *PUNTIUS CONCHONIUS* (HAMILTON-BUCHANAN)[1]

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Puntius conchonius (Ham.-Buch.) is one of the most beautiful and favourite ornamental fish among the Puntid species. It has been reported from most parts of India (Day 1878; Talwar and Jhingran 1991), including Garhwal Himalaya (Singh *et al.* 1987). The body is deep and compressed. Its head length is 4.4 to 5.1, body depth is 2.9 to 3.3, predorsal length is 2.3 to 2.5 and prepelvic length is 2.4 to 2.7 in ratio of total length. Scales are medium about 22-26 in the lateral line, however, the lateral line ceases after about 5 to 9 scales. There is a dark black blotch on 15-19 scales just above the anal fin on both the sides. During the present biological investigations on the fish collected from Mandal – a rain-fed stream, from Garhwal Himalaya (29° 26' -31°28' N and 77° 49'-80° 6' E), some striking sexual dimorphic differences were observed.

Sexual dimorphism in fish has already been reported in different species by Swarup and Swarup (1975), Tilak (1975),

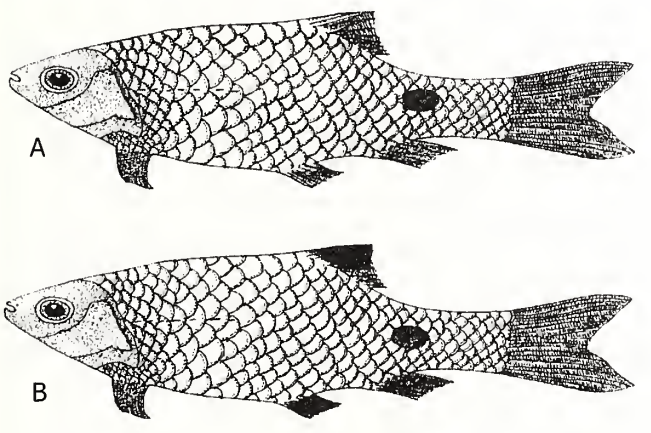

Fig. 1: Sexual dimorphism in *P. conchonius*
A. Female, B. Male

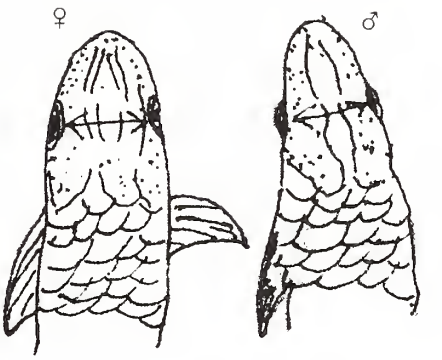

Fig. 2: Dorsal surface of head/snout of female and male *P. conchonius*

Table 1: Some important taxonomic characters in both sexes of *Puntius conchonius* (Ham.-Buch.)

Character in ratio	Male	Female
HL in ratio of TL	4.53-5.36 (4.997+0.26)	4.35-5.2 (4.97+0.25)
CL in ratio of TL	4.41-5.38 (4.87+0.3)	4.3-5.28 (4.70+0.26)
MBD in ratio of TL	2.92-3.36 (3.096+0.12)	2.89-3.39 (3.10+0.13)
PDL in ratio of TL	2.19-2.43 (2.326+0.07)	2.25-2.53 (2.35+0.09)
PPL in ratio of TL	2.34-2.61 (2.47+0.09)	2.38-2.69 (2.48+0.08)
ED in ratio of HL	2.6-3.75 (3.06+0.32)	2.8-3.75 (3.171+0.25)

TL = Total length, HL = head length, CL = caudal length, MBD = maximum body depth, PDL = predorsal length, PPL = prepelvic length, ED = Eye diameter

Pathni (1978), Ritakumari and Nair (1979) and Badola *et al.* (1982). Our observations on sexual dimorphism in *Puntius conchonius* (Ham.-Buch.) is based on the study of fifty male and female specimens each, collected between November 2003 and January 2004. The fishes were segregated on the mentioned sexual dimorphic characters, and dissected for confirmation. We got hundred percent confirmation and then decided to report it for an addition to the scientific knowledge based on the study of morphometric characters.

The detailed morphometric and meristic characters of both male as well as female fish were studied (Table 1), but no striking difference was seen. The differences are (i) male with dark black shade on the dorsal, ventral and anal fins, absent in female (Fig. 1), (ii) Upper portion of the body shining olive green and lower portion silvery in both sexes; but there is pinkish colour in males between these two portions, which is not visible in the female specimens, and (iii) the snout is broader on upper side in the female compared to the male (Fig. 2).

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21. SEXUAL DIMORPHISM IN FLATHEAD GREY MULLET *MUGIL CEPHALUS* (LINNAEUS)[1]

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Introduction

Sexual dimorphism is widespread in nature and can be influenced by sex specific natural selection resulting from ecological differences between the sexes (Reimchen and Nosil 2004). Differences in the selective pressures experienced by the sexes can ultimately result in the evolution of sexual dimorphism of morphological traits (Andersson 1994). Many fish species show sexual dimorphism, a condition where males and females are different in colour and/or form, thus sexes can be detected externally.

Comparison of morphological features in males and females of similar length group facilitate to work out the sexual dimorphism. Species that show difference in coloration between sexes are said to display sexual dichromism (Martin Moe 2002).

The study on sexual dimorphism is of great significance in taxonomy, bionomics, reproductive biology, monosex culture of fishes, hybridization experiments, hormonal sex control, identification of maturity stage, identification of hybrids, breeding season, induced breeding, seedling production technology and also in the observation of courtship and mating, mate selection, and preference.

The study on sexual dimorphism has been carried out in a very few species of fishes like *Tetraodon travancoricus* (Inasu 1993), *Puntius filamentosus* (Thobias 1974), *Priacanthus hamrur* (Tessy and Inasu 1998), and *Ompok bimaculatus* and *Horabagrus brachysoma* (Kurian and Inasu 1997).

The present work deals with the sexual dimorphism of the Flathead Grey Mullet *M. cephalus* belonging to Order Mugiliformes and Family Mugilidae. It is commonly called 'Kanambu', 'Alameen' or 'Thirutha' in Malayalam ,'Madavai' in Tamil, and 'Kathiparega' in Telugu (Talwar and Jhingran 1991). Grey Mullets are mostly marine, distributed in temperate and tropical seas, estuaries and some rivers, but spawn in the

Table 1: Average body weight in each length group of male and female *Mugil cephalus* (Linn.)

Length group	Total number of Fish examined		Average weight (gms)	
(mm)	Male	Female	Male	Female
160 -169	27	31	45.71	49.40
170 -179	38	33	64.06	66.70
180-189	44	25	79.21	82.94
190-199	30	41	82.5	87.00
200-209	-	24	-	100.20
210 – 219	-	27	-	108.70

sea. This non-predatory fish feeds on zooplankton, phytoplankton and detritus in the bottom mud.

M. cephalus is one of the common species of mullets in the Indian region which is abundant in catches from the Chilka lake (Orissa), Mahanadi and Godavari estuaries, Pulicat lake (Tamil Nadu) and in the backwater lakes of Astamudi and Vembanadu (Kerala). They withstand wide fluctuations in salinity and suitable for brackish water polyculture along with shrimps, *Chanos* and predatory fish like *Lates* (Thampy 2002). Sea ranching of *M. cephalus* has been done successfully in Hawaii (Grimes 1998) and along the Gujarat coast (Anon. 2000). *M. cephalus* is reported as a potential fish for induced maturation and breeding technologies with great success (Rao 2000). So the study on sexual dimorphism is of great significance in this fish as it is a preliminary step to distinguish males and females.

Method

About 320 specimens (males 139 and females 181) of adult *M. cephalus* were collected in fresh condition from February to July 2005 from the estuarine region of Kanakankadavu (Ernakulum district, Kerala). They were sorted into various length groups. The fine morphological differences between males and females of the same length group were studied and compared, and total weight of each fish was recorded separately.

Discussion

In *M. cephalus*, mature male acquires a pinkish red hue on the body particularly on the basal portion of 1st and 2nd dorsal fins, ventral fins and anal fin during the approach of the breeding season, but in females such coloration is not noticed. The fine colour difference between the two sex groups tend to fade once the breeding period is over. This pattern of temporary sexual dichromism is also observed in *Tetraodon travancoricus* (Joshi 2004), *Horabagrus brachysoma* (Inasu 2004), *Anabas testudineus* (Roychan 2005), and *Bendelisis chedra* (Pathani and Gaur 1989). It has a passive or active role in reproductive behaviour as the bright body colour attracts the opposite sex and helps in completing the spawning act (Martin Moe 2002 and Roychan 2005). Variation in colour can also be due to environmental, nutritional and ecological factors, such as competition, and predation. The endocrine glands also play an important role in breeding coloration.

Females are heavier than the males of the same length group. For facilitating a better comparison the average body weight in each length group of male and female is given in Table 1. The large body size of female fish can be explained as the fecundity of the fish. Andersson (1994) reported that females tend to have larger gonads than males with large energy rich eggs, whereas males have much smaller gonads that produce numerous relatively inexpensive sperm.

This study has focused on the ultimate explanations of the observed sexual dimorphism in *M. cephalus* (Linn.), yet it would be interesting to further examine the proximate causes of these differences.

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22. NEW RECORDS OF TWO EEL FISHES FROM GREAT NICOBAR ISLAND, BAY OF BENGAL[1]

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Highly diversified fishes occurring in the coastal waters and coral reef areas of the Andaman and Nicobar Islands have been a source of continuous biodiversity research by various ichthyologists (Rao *et al.* 2000). During the present study, detailed investigations on the fish samples collected from the coral reef areas around the Great Nicobar Island were made. A total of 176 species of fin fishes belonging to 106 genera, 71 families and 15 orders were recorded. Among these, two species are new distributional records to Andaman and Nicobar Islands, Bay of Bengal. The descriptions of these two fishes belonging to families Muraenidae and Moringuidae, classified under the order Anguilliformes, are given here.

Systematic Account

Order: **Anguilliformes**

Family: **Muraenidae**

1. **Ribbon Eel *Rhinomuraena quaesita*** Garman 1888

Rhinomuraena quaesita Garman 1888. Bull. Essex. Inst. Pp. 114.

Rhinomuraena quaesita: 1990. Randall *et al.* Fishes of the Great Barrier Reef and Coral Sea. Pp. 41.

Material examined: One specimen, 20.i.2003, Lashman beach, east coast of Great Nicobar Island, Reg. No. 5167(A).

Description (mm): Total length 755, eye diameter 4, distance from snout to dorsal 30, body depth 15, caudal fin length 4, length of dorsal fin 725, ventral 510. Body slender and elongated; cleft of mouth reaching far behind eye; triserial villiform teeth in both the jaws; tip of jaws with barbel-like filamentous appendages; tube of anterior nostril with foliaceous appendages; dorsal and anal fins well developed, origin of dorsal fin well before gill openings; pectoral fins absent; dorsal, anal and caudal fins confluent. Body bluish black with yellow dorsal fin, anal fin black; both dorsal and anal fins with white margin.

Habitat: Found in sandy beach areas.

Distribution: Central and western Pacific to Islands of Indian Ocean.

Family: **Moringuidae**

2. **Black-tailed Thrush Eel *Moringua bicolor*** Kaup 1856

Moringua bicolor Kaup 1856, Cat. Apod. Fish. Pp. 107.

Rataboura bicolor: Munro 1982. The Marine and Freshwater Fishes of Ceylon. Pp. 63.

Material examined: One specimen, 16.ii.2003, Kichad Nullah, west coast of Great Nicobar Island, Reg. No. 5168(B).

Description (mm): Total length 685; eye diameter 3; distance from snout to dorsal 630; depth of the body 14; length of pectoral fin 6; caudal 5; dorsal 55; ventral 50; 5 conical and short teeth arranged in single rows in jaws. Body elongate, worm-like and cylindrical; posterior nostril opens in a pore in front of eye; eyes small and covered with skin; lower jaw projecting a little in front of snout; lateral line present; dorsal and anal fins small, confined to tail region; caudal region forming a point with which dorsal and anal fins are confluent with caudal fin. Upper half of body brownish and lower half pale yellow, caudal fin blackish with a white edge, other fins light yellow.

Habitat: Found around sea grass beds and reef areas

Distribution: India (Great Nicobar Island), Sri Lanka and North Pacific, Japan, Laccadive Sea, Indonesia and Philippines.

ACKNOWLEDGEMENTS

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23. *BALITORA BRUCEI* (GRAY) AND *GLYPTOTHORAX TELCHITTA* (HAMILTON), TWO NEW REPORTS FOR ARUNACHAL PRADESH, INDIA[1]

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Weekly samplings of fish fauna were initiated from three stations near the Police Colony (27° 04.697' N and 93° 35.809' E) Itanagar, Papum Pare district, Arunachal Pradesh, since September 2004. A total of 45 species of fishes and two crustaceans were captured, using a cast net of 2.01 m diameter and mesh size of 7 sq. mm. Among the fishes caught till February 27, 2005, individuals of *Balitora brucei* appeared regularly in the catches from September, 2004 to end February, 2005. Although *B. brucei* specimens were captured regularly during this period their numbers were always found to be very low, with one or two individuals appearing in each catch except for February 27, 2005 when the number increased to four individuals. However, no specimens of *B. brucei* have appeared in the catch since. Samples of *B. brucei*, preserved in 10% formalin, are deposited in G.B. Pant Institute of Himalayan Environment and Development (GBPIHED), N.E. Unit (Collection No. GBP-NE/FF/18, dated 14/09/04).

During the sampling on December 7, 2004, a single individual of *Glyptothorax telchitta* was caught with specimens of *Garra gotyla gotyla*, *Garra annandalei*, *Psilorhyncus balitora*, and *Barilius bendelisis*. This specimen has been preserved and deposited in the Unit's collection (Collection No. GBP-NE/FF/37, dated 07/12/04).

B. brucei were found mostly attached to the boulders in fast moving waters, especially on stones covered with fine algae. *G. telchitta* was found predominantly in the medium current water with slippery stones in river bed and big boulders surrounded.

Balitora brucei have been reported from different parts of India (Talwar and Jhingran 1991; Menon 1999), as well as Bangladesh (Talwar and Jhingran 1991; Kottelat 1998), Bhutan (Talwar and Jhingran 1991; Kottelat 1998) and Nepal (Shrestha 1990; Shrestha 1999). The species have been reported from the Indian states of Assam, Meghalaya and northern West Bengal (Kottelat 1988; Menon 1999; Kapoor *et al.* 2002).

In India, *Glyptothorax telchitta* has been reported from Manipur (Talwar and Jhingran 1991), Mizoram (Kar *et al.* 2000). The species is also reported from the north-eastern states of Meghalaya, Mizoram and Tripura (Sen 2000) It is also known from the Vindhya range of mountains, Uttar Pradesh, Madhya Pradesh, Bihar, where it is common (Talwar and Jhingran 1991). There appears to be no report of either species from Arunachal Pradesh and hence, this is the first report for both *Balitora brucei* and *Glyptothorax telchitta* from the state.

1. ***Balitora brucei* (Gray)** (Fig.1)

1 ex., Weight 4.80 gm, Total length 78.77 mm, Standard length 68.52 mm, Head length 14.46 mm, Head width 13.09 mm, Head depth 4.48 mm, Body depth 9.47 mm, eye diameter 1.33 mm, Interorbital distance 6.21 mm, Nasal distance

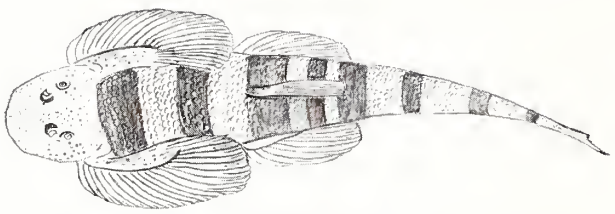

Fig. 1: Dorsal view of *Balitora brucei*

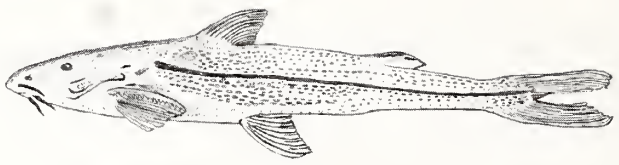

Fig. 2: Lateral view of *Glyptothorax telchitta*

4.95 mm, Caudal peduncle 3.92 mm.

Diagnostic characters: D i 7-8, P i 20-21, V i 10, A 5-6, C 17-18. Dorsal fin originates opposite of ventral, head depressed, mouth ventral, eye small, colour brownish, brown blotches dorsally (8-10) and laterally, dirty yellowish ventrally, lateral line complete, pectoral and ventral fin placed horizontally with brown tinge, pectoral broader than ventral, lower lobe of caudal fin longer than upper with black tinge. Skin rough to touch with minute tubercles.

Behaviour: The fish can tolerate high current waters with algae covered boulders, pebbles. Pectoral and ventral fin, and rays help the fish to anchor to the substratum. It feeds on fine algae on substratum and minute sand particles entangled.

2. ***Glyptothorax telchitta* (Hamilton)** (Fig. 2)

1 ex., Weight 3.60 gm, Total length 78.08 mm, Standard length 66.25 mm, Head length 15.22 mm, Head width 9.29 mm, Head depth 7.39 mm, Body depth 10.16 mm, Eye diameter 1.25 mm, Interorbital distance 3.52 mm, Nasal distance 2.42 mm, Caudal peduncle 3.89 mm.

Diagnostic characters: D i. 5, P 1.8, V i. 5, A ii. 8, C 17. Height of dorsal almost equals height of pectoral, outer mandibular barbel reaches the gill opening, Maxillary barbel reaches up to orbit (versus posterior end of orbit Day, 1878), base of adipose equal to the base of rayed dorsal. Jaws unequal, upper the longer. Eye small, caudal fin deeply forked. Colour blackish with yellowish tinge and two yellowish blotches at the shoulder on both sides of the origin of dorsal fin. Lateral line complete. Occipital process not reaching basal bone of dorsal fin. Adhesive apparatus on thorax longer than broad without any central pit. All barbels shorter than head. Skin tuberculated.

Behaviour: The species is a nocturnal predator and benthopelagic in habitat. It attaches itself to the river bed and remains under the gaps and holes of rocks and boulders. The nasal and mandibular barbels seem to play an important role to identify prey. The species is carnivorous having minute teeth, serrated internally.

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24. TYPE SPECIMEN OF INSECT *ACANTHACORYDALIS HORRENDA* NAVAS (MEGALOPTERA) IN THE COLLECTION OF BOMBAY NATURAL HISTORY SOCIETY[1]

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Order Neuroptera is classified by Imms (1977) into two suborders, i.e. Megaloptera and Plannipennia. Suborder Megaloptera is a small group of rare and primitive insects commonly known as Alderflies and Snake flies and very little information is available on them (Varshney 2002). Ghosh (1998) mentioned that 125 genera and 335 species of Neuroptera are found in India, out of which 8 genera and 25 species belong to the suborder Megaloptera, which is represented by two families, i.e. Corydalidae and Inocellidae. According to Liu *et al.* (2005), eight species of *Acanthacorydalis* are found in Asia of which seven species are restricted only to the Oriental region and one also exists in Palaearctic Region. They have also identified six areas of endemism of this genus of which one is north-east India. Ghosh (2000) has extensively worked on this group of insects found in India and has described three species of the genus *Acanthacorydalis* from northeast India: *Acanthacorydalis asiatica* Wood Mason (described by Wood Mason as *Corydalis asiatica*), *A. orientalis* McLachlan and *A. horrenda* Navas. While working out an identification key for these species, Ghosh has remarked that, "due to paucity of the material for examination and non-availability of the literature author reserves comments on the species *A. horrenda* Navas. Varshney (2005) studied the collection of suborder Megaloptera present in Zoological Survey of India (ZSI) and has not mentioned the presence of *Acanthacorydalis horrenda* species in the ZSI collection. The entomological collection of the Bombay Natural History Society has a specimen of *Acanthacorydalis horrenda* Navas labelled as 'type specimen' (Fig. 1).

Fig. 1: *Acanthacorydalis horrenda* Navas

Locality: Naga Hills, *c.* 1,311 m (4300 ft).

Date of Collection: April, 1930. Sex: Male.

Collected by: Capt. J.E. Mibreg.

Determined by P.J. Navas (1931).

Diganostic Characters: Head square-shaped with three prominent ocelli. The black and brownish markings present on head and thorax are symmetrical. Antenna broken (not present). Male mandible dark black, two times as long as head, with three minute teeth. Pronotum and mesonotum light brown in middle and black on either side, metanotum brown and little black on sides. Wings smoky and not dark at anterior margin. Forewings with brown spots. Legs black. Male tenth tergite short, stout, and curved ventral. The description of female is not available.

Measurement: Wing Span – Fore wing: 76.50 mm; Hind Wing: 68.55 mm; Body length: 55.48 mm; Prothorax: 15.00 mm; Mesothorax: 5.0 mm. Metathorax: 6.0 mm; Abdomen: 16.35 mm.

The male genitalia are also visible in the specimen.

The body markings and wing venation are illustrated in the attached photograph.

Remarks: Many attempts to obtain the original description of the species published by Navas are unsuccessful. It is observed that *A. horrenda* (Navas) is distinct from other two Indian species in different markings on the head and thorax, long mandibles in male. Anterior edge of wings not dark. The status of this species would be clarified on receipt of its original description and this paper will be useful in this regard.

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25. ADDITIONS TO THE COCCINELLID FAUNA OF THE ANDAMAN ISLANDS AND THE BIOLOGY OF THE ENDEMIC *CHILOCORUS COELOSIMILIS* KAPUR 1966 (COLEOPTERA: COCCINELLIDAE)[1]

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In spite of their economic importance both as phytophages and as efficient predators of crop pests, the Coccinellidae of the Andaman Islands remain poorly known to this day. The first Coccinellid, *Epilachna nevilli* from these Islands was described as an endemic species by Dohrn in 1880 – 22 years after the British occupied these Islands, with the purpose of establishing a penal colony. In the next 51 years, only two more species were added, of which *Rodolia andamanica* Wise was also endemic. No more additions were made till Kapur (1966) based largely on specimens collected sporadically between 1959 and 1964 by members of the Zoological Survey of India, recorded 26 more species, with four endemics from these Islands in 1966. With this the total number of species known from these islands rose to 29, of which 6 are endemics (Kapur 1966). No additions have since been made to the Coccinellid fauna of the Andaman Islands. It was in this context that the current study was undertaken, to enable the further documentation of the Coccinellid diversity of these islands.

The Andaman archipelago is a chain of a little over 320 islands, situated in the Bay of Bengal between the 10° N and 14° N. Oceanic in origin (Prashanth Mohanraj and Veenakumari 1996), these Islands were inhabited solely by hunter-gatherer tribes for centuries, till the British established themselves here in 1858 following an earlier abortive attempt to do so in the last decade of the eighteenth century. It was only after the arrival of the British in the mid-nineteenth century, that these Islands began to be scrutinized for their natural historical productions.

No special techniques were employed to collect these beetles. Adults were collected from the foliage from both forests and crop fields and processed using routine entomological procedures. The immature stages were also collected whenever noticed, brought to the laboratory and reared.

All the specimens collected/reared were sent to the Natural History Museum, London, to ascertain their identities.

Additions to the native Coccinellid fauna

Twenty seven species of Coccinellids were collected during the course of this study. Twelve of these are being recorded for the first time from these Islands (Table 1). Only four Coccinellids have been identified to the species level,

Table 1: Coccinellidae (Coleoptera: Cucujoidea) recorded for the first time from the Andaman islands, India

Family	Coccinellidae
Subfamily	Sticholotidinae
	**Jauravia pallidula* Motschulsky
	**Serangium* sp.
Subfamily	Scymninae
	Scymnus fuscatus Boheman
	Scymnus sp.
	**Pseudoscymnus* spp. 1 & 2
	**Cryptogonus* sp.nr. *bilineatus* Kapur
	Stethorus sp.
Subfamily	Coccidulinae
	Rodolia fulvescens Hoang
Subfamily	Chilocorinae
	Chilocorus sp.nr. *nigrita* (Fabricius)
	**Platynaspis* sp.
Subfamily	Coccinellinae
	**Bothrocalvia pupillata* (Swartz)
	Harmonia sp.

*Taxa being recorded for the first time from the Andaman islands

Table 2: Duration (days) of the immature stages of *Chilocorus coelosimilis* in the Andaman islands

	Egg	Larval Instar				Prepupa	Pupa	Adult
		I	II	III	IV			
N	4	21	43	63	63	61	59	4
x	2.0	2.1	2.0	2.6	4.5	2.1	6.7	21
Range	-	2-3	2-3	2-6	3-7	2-4	5-10	20-22
S.D.	-	0.22	0.29	0.82	0.99	0.64	0.89	

while two have been found to be akin to, but distinct from, already known species. The remaining, though not identified to the species level, find a mention here because they are different from all the other species, so far, known from here. Six of the genera have never before been reported from these islands and are being recorded from here for the first time.

Life cycle

C. coelosimilis takes from 20 to 22 days to complete its life cycle (Table 2). It passes through 4 larval instars and a distinct prepupal period that lasts from 2 to 4 days. Of all the stages, the pupal period is the longest, lasting 5 to 10 days. The dimensions of the egg and all larval instars are given in Table 3.

Description of immature stages

Egg: The eggs are laid singly on the lower surfaces of the leaflets of the coconut palm (*Cocos nucifera*: Arecaceae) among scale insects (*Aspidiotus destructor* Signoret). They are orange-yellow in colour with a smooth, glossy surface and are cigar shaped (widest in the middle, tapering towards either end and terminally truncated). They are attached to leaf surfaces along their longitudinal axes. The larvae emerge from the eggs, by making long, lateral slits which cover about 75 per cent of the length of each egg. The chorion is double-walled with an inner translucent, papery, white layer and an outer, off-white and finely granulated layer.

Larva

I instar: The head is black or deep brown in colour, with a glossy surface. It is covered sparsely with pale cream setae, which become increasingly dense on the frons. The thorax is pale cream in colour and broader than the abdomen. The dorsal shield of the prothorax is suffused with black and it has two rows of tubercles. This instar moves swiftly when active. The legs are translucent black with a distinct black annular marking between the trochanter and femur.

The abdomen is uniformly cream with dorsal, subdorsal and lateral rows of tubercles (6 tubercles per segment). These tubercles are relatively long and cream like the rest of the body for most of their lengths, but dark terminally. Each tubercle has a pale yellow or cream seta at its apex.

The cast skin is ruptured dorsally along the mid-dorsal line. It is papery and pale white in colour, with dark brown tubercular remnants. They feed on coconut scales (*Aspidiotus destructor* Signoret) by making a hole at the periphery.

II Instar: Head and prothorax dirty white or very pale brown with long scimitar shaped spines, which are off-white basally and then blackish along the rest of their lengths. They have long silvery setae for part of their lengths.

The meso and meta thoraxes are deep brown to black with tubercles. Dorsally there is a brownish-black band. The first three and last two abdominal segments are pale brown or off-white in colour. The fourth, fifth and sixth segments have a deep brown-black band each.

III Instar: The larva is white with black tubercles and black legs. The tubercles are clothed with setae, which are black basally and whitish or silvery on top. The prothorax has 5 tubercles (2 dorsal, 2 subdorsal and 1 lateral). The spiracles are located between the dorsal and subdorsal rows of tubercles in pale black insular patches. A deep longitudinal constriction passes all along the length of the body between the subdorsal and lateral rows of tubercles. The tubercles are markedly reduced in size on the last abdominal segment.

IV Instar: The fourth instar is not described here because we failed to collect sufficient data.

Table 3: Dimensions (mm) of the immature stages of *Chilocorus coelosimilis* reared in the laboratory in the Andaman islands

	Egg	Larval Instar			
		I	II	III	IV
N	10	16	43	63	63
x	0.9	1.0	2.2	3.2	4.6
Range	0.8-1.0	0.9-1.2	1.6-3.5	2.2-4.8	3.0-5.7
S.D.	0.07	0.11	0.32	0.48	0.63

Pupa

It forms within the last larval skin, which splits along the mid-dorsal line. The exuvia of the final instar larva splits from behind the head to the sixth abdominal segment. The old larval integument is white, with remnants of the prominent

black tubercles projecting from it; even the remnants of the legs are retained with almost no distortion. The yellow pupa appears to have thrust itself out along the mid-dorsal region. The dorsal surface of most of the thorax, a portion of the wing pads and a greater part of the dorsal surface of the abdomen are visible. This whole exposed surface is covered with very small white setae. Along the mid-dorsal abdominal segment are present depressions with a shade of black that spreads out from the depression towards the posterior margin of each segment. There is a terminally truncated tubercle at the junction of the meta thorax and the first abdominal segment, while there is another very small tubercle along the lateral margin on this abdominal segment. The entire dorsal surface is clothed with brown setae.

Natural enemies

Multiple parasitism by the wasp *Homalotylus* sp. (Hymenoptera: Encyrtidae) was observed in *C. coelosimilis*. Four of these parasitoids emerged from one pre-pupa. This particular specimen was collected from the field as a second instar and reared individually in a glass tube. As parasitization could not have occurred in the laboratory under these rearing conditions it can be said, with a fair degree of certainty that these are larval-prepupal parasitoids, which parasitize early instars of the Coccinellid.

Kapur's (1966) is the most recent and the most comprehensive treatment of the Coccinellidae of these islands. In addition to nine species of plant feeding Epilachninae, he detailed 20 species of predaceous Coccinellinae *sensu lato* fr[illegible] these islands. The current survey reveals a much richer predaceous Coccinellid fauna on these Islands, including six genera hitherto not recorded from here. Of these only in two cases it was possible to identify the species. Booth (1993) is of the opinion that the *Harmonia* sp. collected from South Andaman is an undescribed species that is probably endemic to these Islands. Similarly, one of the *Scymnus* sp. collected on Rutaceae, he says, is not typical of the genus. Other genera like *Pseudoscymnus*, *Cryptogonus*, and *Chilocorus*, which are already known to be present on these Islands (*vide* Kapur 1966), are represented by additional species indicating that the Coccinellidae remain under-explored on these islands. This calls for further and more rigorous surveys and studies on this important group of predatory beetles on these Islands.

Aspidiotus destructor Signoret and *Neofurcaspis andamanensis* Green are the two diaspidine (Homoptera) scales that occur on coconut in these islands (Bhumannavar *et al.* 1991). The former in particular is known to be a serious pest of coconut in some parts of the world. The population of this scale builds up on these islands during summer (January to March). This population build up is, however, not high enough to cause significant damage to the crop. Apparently a conglomerate of scale insects prevents the build up of the pest to damaging levels. Ten species of predatory Coccinellids (namely *J. pallidula*, *Scymnus* sp., two unidentified species of *Pseudoscymnus*; *Cryptogonus* sp. nr. *bilineatus*, *Chilocorus nigrita*, *C. coelosimilis*, *Pseudaspidimerus lambai*, *Telisimia* sp., and *Serangium* sp.) have so far been found to occur on coconut on these Islands. Nine of these are predators of scales. *Serangium* sp. is the only one from among these that does not feed on scales, but feeds on whiteflies instead.

In addition to these, a species of *Cybocephalus* (Coleoptera: Nitidulidae), which is a predator of scales in both its adult and larval stages, also occurs on coconut in these islands. All these predators in concert appear to be efficient in keeping the scales of coconut in check.

Other interesting taxa collected during the course of the present study are mentioned below. *B. pupillata* was collected on the leaves of *Ficus* from the Mount Harriet National Park in South Andaman. This probable aphid predator is known from southeast China and Java. It has so far not been recorded from the Indian subcontinent. *R. fulvescens*, a predator of scales, was collected from the small island of Havelock. First described in 1980 from Vietnam, this species is poorly known (Booth 1994). Similarly an unidentified species of *Scymnus*, which differs markedly from typical members of the genus, was collected on Rutaceae in S. Andaman. All these taxa require further collection and study. Focused studies are necessary on the Coccinellidae of the Andaman and Nicobar Islands. Like all oceanic islands, these Islands have a significant proportion of endemic species, which need to be collected and studied. Percentage endemism among the Coccinellids in Kapur's (1966) study was found to be 21%. The current study reveals the presence of six hitherto unrecorded genera, and an equal number of probably new species that require further study. Some or all of these six species, which remain unidentified, could turn out to be new indicating the rudimentary state of the knowledge of the Coccinellidae of these Islands. This situation has to be remedied with more rigorous and sustained studies on this important Coleopteran family on these islands.

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26. ADDITIONS TO LARVAL HOST PLANTS OF BUTTERFLIES OF THE WESTERN GHATS, KERALA, SOUTHERN INDIA (RHOPALOCERA, LEPIDOPTERA): PART 1[1]

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Introduction

Three pioneer naturalists, E. H. Aitken, J. Davidson and T. R. Bell started the work on larval host plants of butterflies of the Western Ghats, southern India. Since their early work there has been no extensive study on the host plants of the butterflies in this region (Kunte 2000, 2006). In his report Kunte (2006) reported 26 new host plants of Western Ghats butterflies, bringing the total number of host plants of early stages of Western Ghats butterflies close to 450. In the present note, we add another dozen plants to this growing list of host plants of butterflies of the Western Ghats. This also includes new families of host plants for a few butterflies, e.g. Zingiberaceae for *Gangara thyrsis*. Our records have been checked against the records of Bell (1910-1927), Wynter-Blyth (1957), Kunte (2000, 2006) and the most recent exhaustive compilation of larval host plants of Oriental Lepidoptera by Robinson *et al.* (2001). The list of floras from which plant identities and current scientific names have been confirmed is given below in references.

Our observations are from southern Western Ghats, in the districts of Thiruvananthapuram and Kollam, from the state of Kerala (approx. 8° 18'-9° 55' N and 76° 18'-77° 25' E). Some supporting observations are from neighbouring districts of Pathanamthitta, Kottyam and Alapuzha. Specific localities from where the caterpillars were collected were: 1) Thiruvananthapuram city suburbs, especially around Aakulam lake, 2) Government Medical College campus, Thiruvananthapuram, 3) Ponmudi-Kallar valley region (8° 45' N; 77° 6' E), Thiruvananthapuram district, 4) Chengannur in Alappuzha district, and 5) Thenmala region (8° 50' N; 77° 15' E), Kollam district. All observations were made between 2000 and 2005.

Methods

Caterpillars collected were reared in plastic containers suitable for their size, e.g. for a 3 cm long caterpillar we used a 9 cm x 6 cm x 6 cm sized cage. Holes of size 1 mm x 1 mm per sq. cm were provided for sufficient aeration and maintenance of appropriate humidity. Food plants were changed, the cage was cleaned and fresh leaves were put every day. We included records only when butterflies were successfully reared from larvae, thus it excludes oviposition mistakes by these species.

Family Nymphalidae

1. ***Melanitis leda* Linnaeus** Common Evening Brown

Rottboellia cochinchinensis (Lour) W. Clayton, Poaceae, a tall gregarious herb in open spaces and roadsides, suburbs of Thiruvananthapuram, July and December 2004.

Brachiaria mutica Stapf, Poaceae, a gregarious tall grass at edges of water and in marshes, at Aakulam, Thiruvananthapuram city suburbs, January-March 2005.

2. ***Ypthima hnebneri* Kirby** Common Fourring

Axonopus compressus (Swartz) Beauv., Poaceae, a small to medium sized herb at Aakulam, Thiruvananthapuram city suburbs, January-February 2005.

3. ***Orsotrioena medus* Fabricius** The Nigger

Brachiaria mutica Stapf, Poaceae, a gregarious tall grass at edges of water and in marshes at Aakulam, Thiruvananthapuram city suburbs, January-February 2005.

Family Lycaenidae

1. ***Rathinda amor* Fabricius** Monkey Puzzle

Mangifera indica Linn., Anacardiaceae, large tree in homesteads and *Meiogyne pannosa* (Dalz.) J. Sincl., Annonaceae, small tree, both in suburbs of Thiruvananthapuram city, 2000 and 2002 respectively.

2. ***Zesius chrysomallus* Hübner** Redspot

Terminalia catapa Linn., Combretaceae. A large tree; *Smilax zeylanica* Linn., Smilacaceae, a climber in coastal forests both plants at Aakulam. Lake side, Thiruvananthapuram. Red ants *Oecophylla* spp. were attending to the larvae while they fed on the leaves of these plants, and pupated inside ant shelters. Observed during September 2000 and November 2004 respectively.

Family Hesperiidae

1. ***Tagiades litigiosa* Möschler** Water Snow Flat

Dioscorea alata Linn., Dioscoraceae, climber cultivated in homesteads observed at Chengannur in Alappuzha June-July 2003; Thenmala, Kollam February 2004.

2. ***Tagiades gana* Mabille** Suffused Flat

Dioscorea alata Linn., Dioscoraceae, climber cultivated in homesteads, Chengannur in Alappuzha June-July of 2003; Thiruvananthapuram city outskirts from 2000 to 2004, Kallar September 2003 and 2004.

3. ***Spialia galba* Fabricius** Indian Skipper

Melochia corchorifolia Linn., Sterculiaceae, a herb seen around habitations and disturbed places in suburbs of Thiruvananthapuram, July 2003.

4. ***Halpe porus* Mabille** Moore's Ace

Bambusa striata Lodd. ex Lindl., Poaceae, large tree in gardens, Government Medical College campus Thiruvananthapuram, August-September 2004.

Ochlandra scriptoria (Dennst.) Fisch., Poaceae tall reeds growing in clumps seen along waterways and canals at Chengannur in Alappuzha, October 2002.

Both sexes were reared and detailed notes on their natural history will be published later.

5. ***Sovia hyrtacus* de Nicéville** Bicolor Ace

Ochlandra travancorica Benth., Poaceae, gregarious reeds seen near water, and deciduous and mixed forests Kallar, Thiruvananthapuram, December 2001 and December 2003. Two larvae obtained both in reeds in a riparian region.

6. ***Iambrix salsala* Moore** Chestnut Bob

Setaria barbata (Linn.) Kunth, Poaceae, small to medium sized herbs, suburbs Thiruvananthapuram, June-July of 2002 to, Aakulam lake at Thiruvananthapuram, October-December of 2000 to 2004; *Axonopus compressus* (Swartz.) Beauv., Poaceae, small to medium sized herbs, suburbs of Thiruvananthapuram, July 2004. *Brachiaria mutica* Stapf Poaceae, a gregarious tall growing grass at edges of water and in marshes, at Aakulam, Thiruvananthapuram city suburbs, January 2005.

7. ***Psolos fuligo* Mabille** Coon

Marantha arundinacea Linn., Maranthaceae, stemless gregarious herb widely cultivated, suburbs of Thiruvananthapuram, June-July and September-November of 2001 to 2004. Two distinct breeding seasons are noted corresponding to the rains and sometimes throughout the time the food plants are plenty; *Schumannianthus virgatus* Rolfe., Maranthaceae, a tall erect perennial herb in marshy and moist hilly regions at Thenmala in Kollam district and Kallar at Thiruvananthapuram January 2003 and 2004.

8. ***Udaspes folus* Cramer** Grass Demon

Zingiber zerumbet Sm., Zingiberaceae, tall herb in moist soil often found gregarious in hilly regions in suburbs of Thiruvananthapuram, November-December of 2001 to 2004.

9. ***Notocrypta curvifascia* Felder & Felder** Restricted Demon

Zingiber zerumbet Sm., Zingiberaceae, tall herb often found growing gregarious in moist soil in hilly regions in suburbs of Thiruvananthapuram, December 2004. Has been previously reported by Veenakumari *et al.* (1998) from Andaman and Nicobar Islands, new record for southern India.

10. ***Gangara thyrsis* Fabricius** Giant Redeye

Zingiber officinale Rosc., Zingiberaceae, medium sized perennial herb cultivated widely in suburbs of Thiruvananthapuram, November 2004. Palms (Arecaceae) are usual host plants; this is a new host plant family for this species.

11. ***Matapa aria* Moore** Common Red Eye

Bambusa striata Lodd. ex Lindl., Poaceae, large tree in gardens in suburbs of Thiruvananthapuram, May-June of 2001 to 2004.

Ochlandra travancorica Benth., Poaceae; gregarious reeds seen near water, and deciduous and mixed forests at Aakulam, Thiruvananthapuram May-June and November-January 2001-2004.

Ochlandra scriptoria (Dennst.) Fisch., Poaceae, tall reeds growing in clumps seen along waterways and canals at Chengannur in Alappuzha, October 2003.

12. ***Aeromachus pygmaeus* Fabricius** Pygmy Scrub Hopper

Ischaemum indicum (Houtt.) Merrill, Poaceae, a small herbaceous grass in open place, edges of roads and in lawns of gardens at Aakulam, Thiruvananthapuram during October 2004-February 2005.

13. ***Oriens goloides* (Moore)** Indian Dartlet

Axonopus compressus (Swartz) Beauv., Poaceae, a small to medium sized herb at Thiruvananthapuram city suburbs, July 2003 and July 2004.

Oplismenus compositus Beauv, Poaceae, small perennial grass in shady places in suburbs of Thiruvananthapuram city 2003 and at Thenmala, Kollam district, November 2004; *Setaria barbata* (Linn.) Kunth Poaceae, a small to medium sized herb, Thiruvananthapuram, June-July of 2003 to 2004.

14. ***Cupitha purreea* Moore** Wax Dart

Quisqualis indica Linn., Combretaceae, large climbers cultivated in gardens and seen near settlements at Kallar, Thiruvananthapuram, December 2004-January 2005.

15. ***Potanthus pseudomaesa* Moore** Pseudomaesa Dart

Axonopus compressus (Swartz) Beauv., Poaceae, a small to medium sized herb at Aakulam, Thiruvananthapuram city suburbs January 2005.

16. ***Telicota colou* Fabricius** Pale Palm Dart

Bambusa striata Lodd. ex Lindl., Poaceae, large tree in gardens, *Ochlandra travancorica* Benth., Poaceae, gregarious reeds seen near water, and deciduous and mixed forests. All observations at Thiruvananthapuram city suburbs June-July of 2002 to 2004.

17. ***Telicota ancilla* Herrich-Schäffer** Dark Palm Dart

Ochlandra travancorica (Benth.), Poaceae, medium sized trees seen near water, and deciduous and mixed forests.

Bambusa striata Lodd. ex Lindl., Poaceae, large tree in gardens of residential areas in Thiruvananthapuram June-July of 2002 to 2004.

Bambusa wamin Camus, Poaceae, a medium sized tree in gardens of residential areas in Thiruvananthapuram December 2004.

18. ***Baoris farii* Moore** Paintbrush Swift

Ochlandra travancorica Benth., Poaceae medium sized trees seen near a water canal in the suburbs of Thiruvananthapuram, June-July 2001.

Ochlandra scriptoria (Dennst) Fisch., Poaceae, small trees growing in clumps seen along waterways and canals at Chengannur in Alappuzha, December 2004.

Bambusa striata Lodd. ex Lindl., Poaceae, large tree in gardens, Aakulam, suburbs of Thiruvananthapuram, June-July of 2000 to 2004.

Bambusa wamin Camus, Poaceae, medium sized tree in gardens of residential areas in Thiruvananthapuram, December 2004.

19. ***Pelopidas conjucta* Herrich-Schäffer** Conjoined Swift

Rottboellia cochinchinensis (Lour.) W. Clayton, Poaceae, a tall gregarious herb in open spaces and roadsides, suburbs of Thiruvananthapuram, January 2005.

20. ***Borbo ciunnara* Wallace** Rice Swift

Setaria barbata (Linn.) Kunth, Poaceae, medium sized herbs observed at Thiruvananthapuram, June-July of 2002 to 2004.

Axonopus compressus (Swartz) Beauv., Poaceae, a small to medium sized herb Thiruvananthapuram, July 2004.

Rottboellia cochinchinensis (Lour.) W. Clayton, Poaceae, a tall gregarious herb in open spaces and roadsides, suburbs of Thiruvananthapuram, July and December 2004.

Brachiaria mutica Stapf, Poaceae, a gregarious tall grass at edges of water and in marshes, at Aakulam, Thiruvananthapuram city suburbs, January 2003 to January 2005.

ACKNOWLEDGEMENTS

We are thankful to Krushnamegh Kunte who patiently went through the manuscript and helped us with the scientific names of butterflies, their authors, also checked out the hostplant list with the latest available data in this field. We would like to thank Prof. Ravi M., Retd. Professor of Botany, S.N. College, Kollam and Prof. Joemy Augustine, Dept. of Botany, St. Thomas College, Palai, for their help in identifying the plants. Special thanks to Prof. E. Kunhikrishnan, Dept. of Zoology, University of Kerala, Thiruvananthapuram, for his comments on an earlier draft and his helping hand all through the work. We are grateful to Suraj P. Haridas, Jyothy Vijayan, Greeshma S., Kannan V. and our parents for their encouragements and help during larval rearing.

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27. NEW RECORDS OF TWO SPECIES OF SIMPLE ASCIDIANS – *MICROCOSMUS PUPA* (SAVIGNY, 1816) AND *MICROCOSMUS SQUAMIGER* HARTMEYER & MICHAELSEN, 1928 – FROM INDIAN SEAS[1]

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The occurrence of two simple ascidians of the genus *Microcosmus* – *Microcosmus pupa* (Savigny, 1816) and *Microcosmus squamiger* Hartmeyer & Michaelsen 1928 is reported for the first time from Tuticorin coast of India. A review of literature on ascidian systematics reveals that three species of the genus *Microcosmus*, namely *M. curvus* Tokioka, 1954; *M. exasperatus* Heller, 1878 and *M. helleri* Herdman, 1882 have been reported from the east coast of India (Oka 1915; Das 1945; Renganathan 1983, 1986; Krishnan *et al.* 1989). An analysis of the ascidian biofoulants at the pearl oyster farm of CMFRI (T) (8° 48' N; 78° 11' E) adds two more species. The specimens studied have been deposited in the ascidian collections of the museum of the Department of Zoology, V.O. Chidambaram College, Tuticorin, Regn. No. *Microcosmus pupa* (VOCM AS72); *Microcosmus squamiger* (VOCM AS16, AS163, AS185, AS190, AS194, AS207, AS223, AS1467).

Taxonomy: Class: Ascidiacea; Order: Pleurogona; Suborder: Stolidobranchia; Family: Pyuridae; Genus: *Microcosmus*

Microcosmus pupa (Savigny, 1816)

Distribution: New record: Tuticorin. This species has been previously reported from Red Sea (Savigny 1816; Michaelsen 1919), Australia (Kott 1985).

Description

External appearance: Individuals upright, 6 cm long and 3 cm wide. Branchial siphon short, terminal. Atrial siphon lines halfway down the dorsal side directed laterally. They are fixed by their rounded posterior end. Test hard, thin, but tough, with wrinkles, especially in the anterior region. Live specimens dark pinkish orange to reddish brown. On preservation the colour fades to light orange. Siphonal spines 0.05 mm long and pointed. Base of the spine half the length of the spine. Tip of spine narrow, sharp and only slightly curved.

Internal structure: (Fig. 1) Body wall adheres closely to the test. There are 15 medium sized branchial tentacles alternating with rudimentary ones. The tentacles are not bushy. The primary branches are small and the secondary branches minute. The dorsal tubercle is a cushion with a U-shaped opening with both horns coiled 1½ times. Peritubercular area is U-shaped, filled by the dorsal tubercle. Dorsal lamina is long and smooth. There are nine broad overlapping branchial folds on the right, and eight on the left. Four stigmata in a mesh. The internal longitudinal vessels are arranged according to the formula.

E1(12) 2(18) 3(17) 4(24) 4(26) 4(30) 4(28) 3(26) 3(24)DL2(24) 4(28)4(30)4(26)3(24)3(20)2(18)2(12)0E

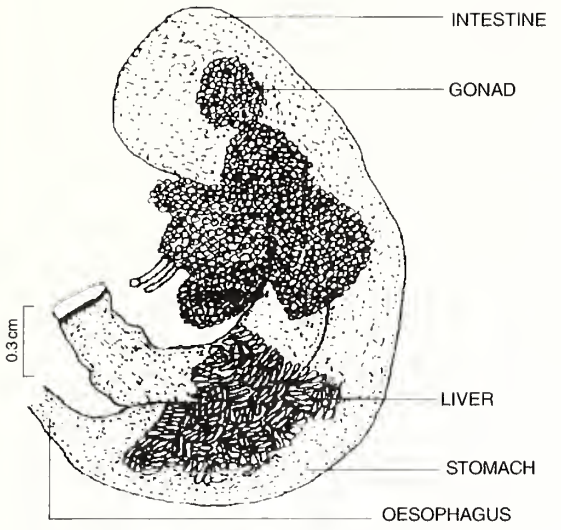

Fig. 1: *Microcosmus pupa*, gut and gonad

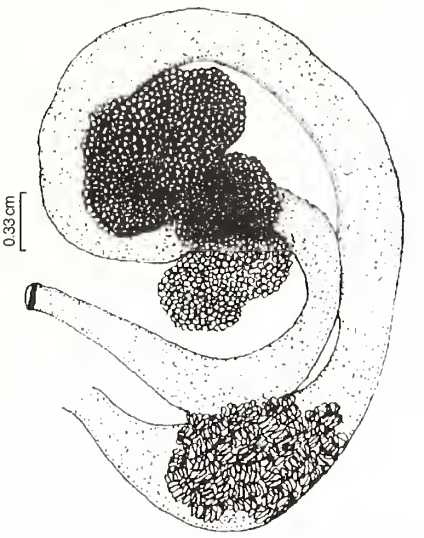

Fig. 2: *Microcosmus squamiger*, gut and gonad

Internal longitudinal vessels are crowded (12-30) on the fold and only (1-4) in the interspace. The gut loop is narrow, deeply curved to form a J-shape. The rectum is curved anteriorly. Liver is compact with parallel folds arranged in groups on the gut wall. Anal border with faint bilobed margin. Gonad is massive, subdivided into 3 lobes. The proximal end of the left gonad is enclosed in the gut loop, the remaining part crosses over the descending limb of the gut loop. Testis follicles present in the centre of mesial surface of the ovary and spread over the gut loop.

Remarks: The presence of the siphonal spines with their almost completely closed bases, narrow flanges, the very numerous male follicles that form an extensive sheet over the body wall and gut loop are distinctive characters described by Michaelsen (1919) for specimens from the Red Sea. All these characters were observed in the present specimen also. However, the present specimen differs from the description of *Microcosmus pupa* Kott (1985) in having shorter siphonal spines, opening of the neural gland coiled more than once. Nine branchial folds on the right and eight on the left, and greater number of internal longitudinal vessels on the folds.

Microcosmus squamiger Hartmeyer & Michaelsen, 1928

Distribution: New record – Tuticorin. This species has been previously reported from Australia (Michaelsen 1908; Hartmeyer and Michaelsen 1928; Kott 1972, 1976, 1985), Red Sea (Michaelsen 1918).

Description

External appearance: Individuals vary in their size and shape. Generally rounded or egg-shaped, 3 cm long and 3 cm wide. They occur in large aggregations and are upright, attached to the substratum by their posterior end. The surface of the test has faint wrinkles and creases, and is reddish brown. The colour fades slightly in preservation. The test is leathery and tough, but not brittle. The inner surface of the test is light purple, and fades on preservation. The apertures are at the anterior end situated at opposite ends directed away from one another. In well narcotized specimens the siphons are conspicuous. The terminal part of the siphon lining has small overlapping curved scales with rounded borders 0.01 to 0.02 mm long.

Internal structure: (Fig. 2) In living individuals the body wall is reddish purple, but on preservation the colour is lost. There are both circular and longitudinal muscles. The siphon lining has red stripes in live specimens. The base of the branchial siphon has 4 pockets, which form a cuspid valve. Branchial tentacles are strong. Dorsal tubercle is a large cushion, which completely fills the peritubercular area with a double spiral cone as aperture. Dorsal ganglion is long and lies behind the dorsal tubercle. Dorsal lamina is long. Branchial sac has 8-9 broad overlapping branchial folds, with 17-25 internal longitudinal branchial vessels crowded on the folds and only 2-3 in the interspace. There are 7-10 stigmata in a mesh. The gut forms a narrow curved loop with an open pole, enclosing the proximal part of the gonad. Liver is compact with parallel lamella, orange in living specimens, but dull green on preservation. Gonads are divided into 3 blocks joined by a median common duct. The left gonad crosses over the descending limb of the gut loop, from the pole of the gut loop, to extend towards the atrial aperture.

Remarks: This species may appear to resemble *Microcosmus exasperatus* in the external features, such as

its tough, leathery, purple-red pigmented test, but differs in the nature of the siphonal armature and the more numerous stigmata in each mesh. It has all characters described by Hartmeyer and Michaelsen (1928), and Kott (1985).

KEY TO THE SPECIES OF *MICROCOSMUS* RECORDED FROM INDIA

1. Siphonal armature absent ..... *M. helleri*
— Siphonal armature present 2
2. Siphonal armature rounded scales ..... *M. squamiger*
— Siphonal armature spines 3
3. Branchial folds 5 on each side, with only 10 internal longitudinal vessels on folds ..... *M. curvus*
— Branchial folds more than 5, with more than 20 internal longitudinal vessels on folds 4
4. Siphonal armature flattened spines ..... *M. exasperatus*
— Siphonal armature needle-like spines ..... *M. pupa*

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28. NEW RECORD OF WOLF SPIDERS (ARANEAE: LYCOSIDAE) OF THE GENUS *HIPPASA* SIMON FROM BANGLADESH[1]

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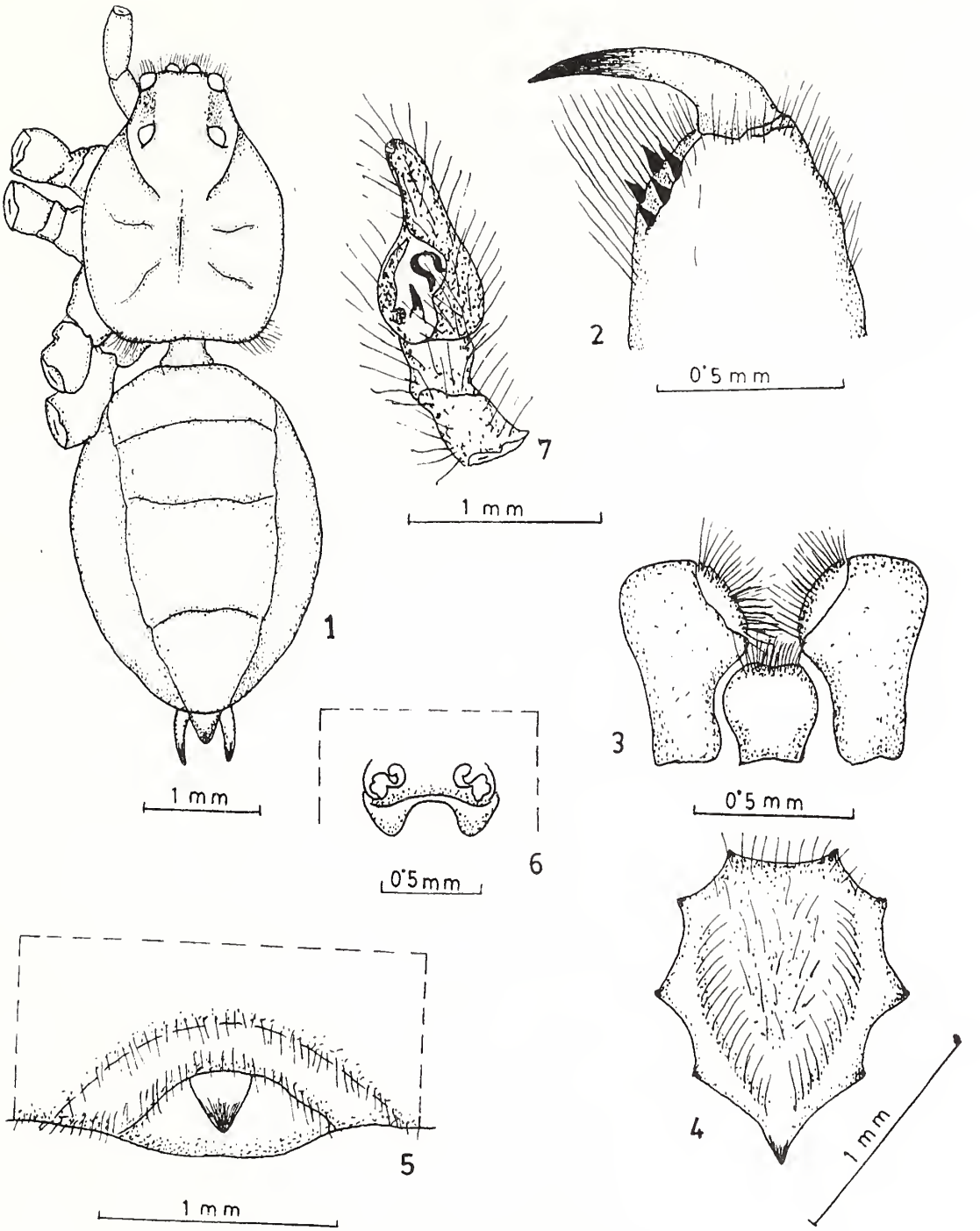
Introduction

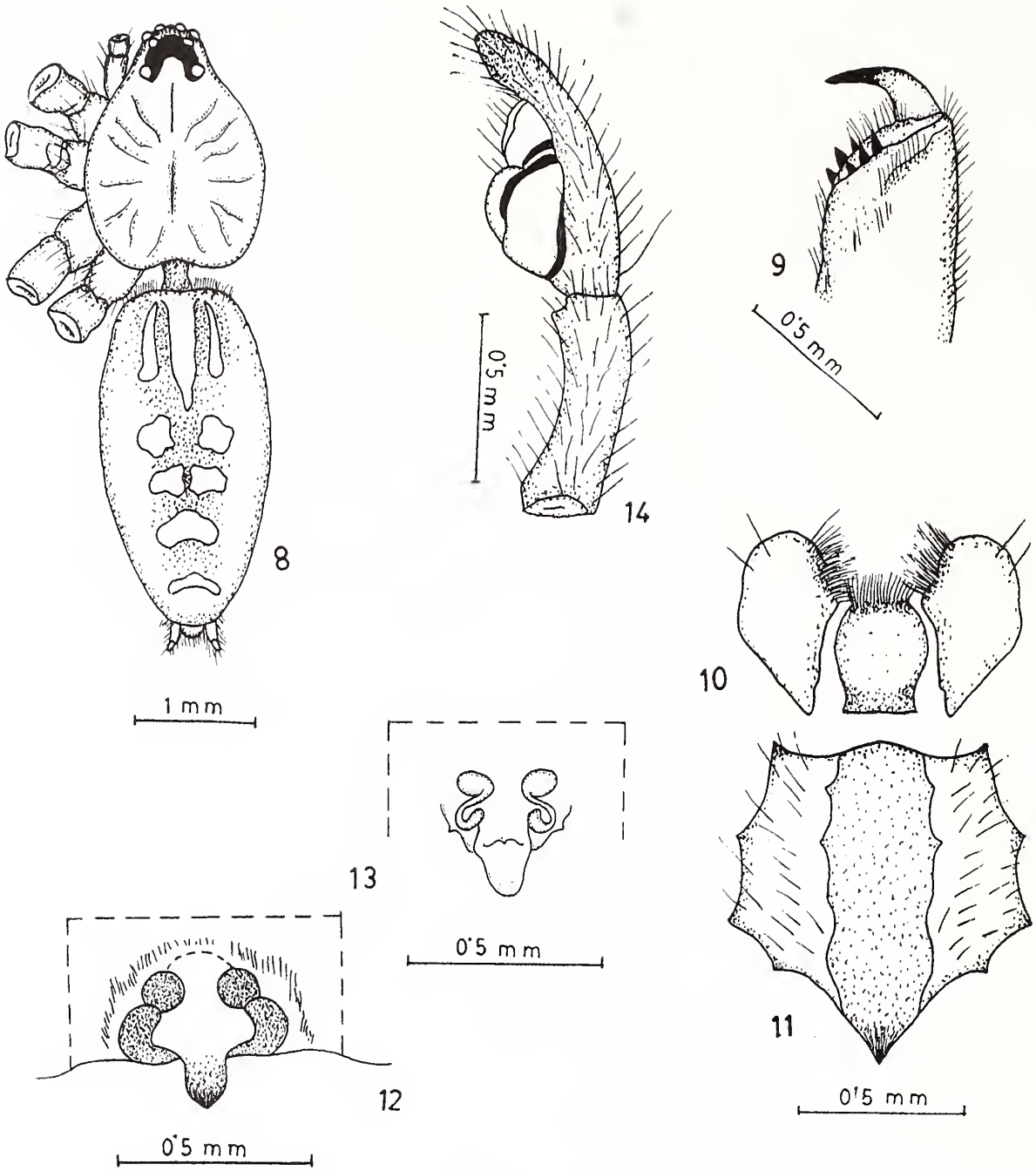
Wolf spiders (Family Lycosidae) are one of the common ground dwelling predators of crop-fields and other habitats. In Bangladesh, works on these spiders are scarce except a few ones are (Chowdhury and Nagari 1981; Chowdhury and Pal 1984; Biswas *et al.* 1993; Okuma *et al.* 1993; Begum and Biswas 1997) found. But in the neighbouring countries like-India (Pocock 1900; Gravely 1924; Tikader 1970, 1977a, 1977b; Tikader and Biswas 1981; Tikader and Malhotra 1976, 1980; Tikader and Mukerjee 1971), Burma (now Myanmar) (Thorell 1895), Pakistan (Dyal 1935), China (Chen and Zhang 1991; Zhao 1993; Song *et al.* 1999), Japan (Tanaka 1985; Yaginuma 1986) where several contributions are made on this group.



Figs 1-7: *Hippasa greenaliae* (Blackwall)
1. *H. greenaliae* (dorsal view), 2. Chelicerae, 3. Maxillae and Labium, 4. Sternum, 5. Epigynum, 6. Internal genitalia, 7. Male palp

The present paper deals with four newly recorded species of the genus *Hippasa* Simon from Bangladesh. All these species are variable in some external morphological characters and measurements with the earlier described species. Therefore, only a brief description of some variable characters and measurements of body segments are presented with necessary drawings for each of the species. The specimens are identified from the Zoological Survey of India, Kolkata and the measurements are taken in millimetres.

The materials are at present in the collection of the Department of Zoology, Government P.C. College, Bagerhat and will be deposited to the Museum of the Department of Zoology, University of Dhaka, Bangladesh, in due course of time.



Figs 8-14: *Hippasa holmarae* Thorell
8. *H. holmarae* (dorsal view), 9. Chelicerae, 10. Maxillae and Labium, 11. Sternum, 12. Epigynum, 13. Internal genitalia, 14. Male palp

Systematics

Genus: *Hippasa* Simon 1885

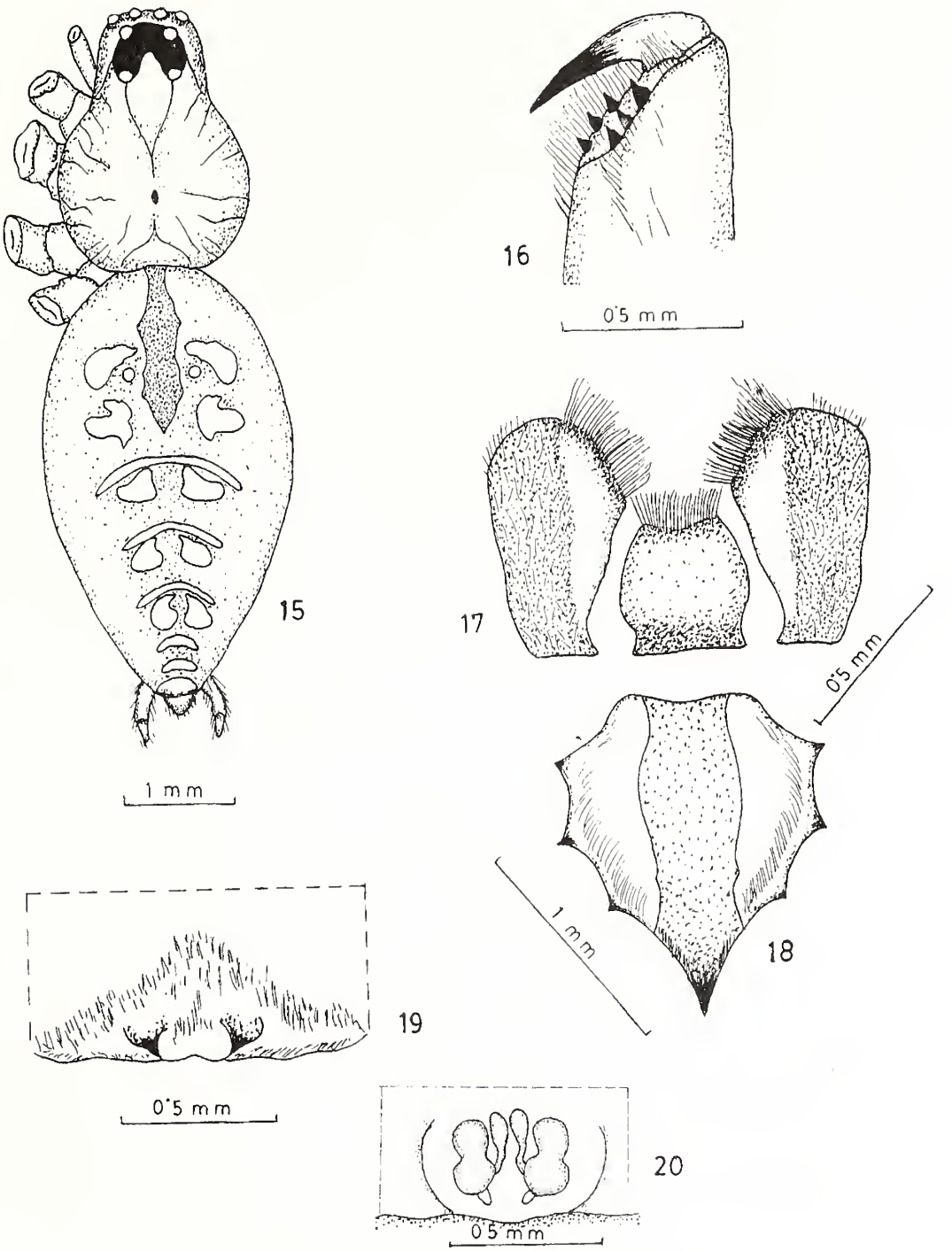
1885. *Hippasa* Simon, Bull. Soc. Zool. Fr., 10: 31.

Diagnosis: Cephalothorax longer than wide, medially usually wide, centrally with a deep brown fovea. Eyes in 3 rows – anterior, middle and posterior; anterior row nearly straight or slightly recurved; eyes of 2nd and 3rd row basally with black patches; anterior row of eyes longer than the 2nd; space enclosed between the posterior eyes wider behind. Sternum with a black mid-longitudinal band.

Abdomen long, nearly cylindrical; posterior spinnerets considerably longer than the anterior spinnerets.

Type-species: *Hippasa agelenoides* (Simon)

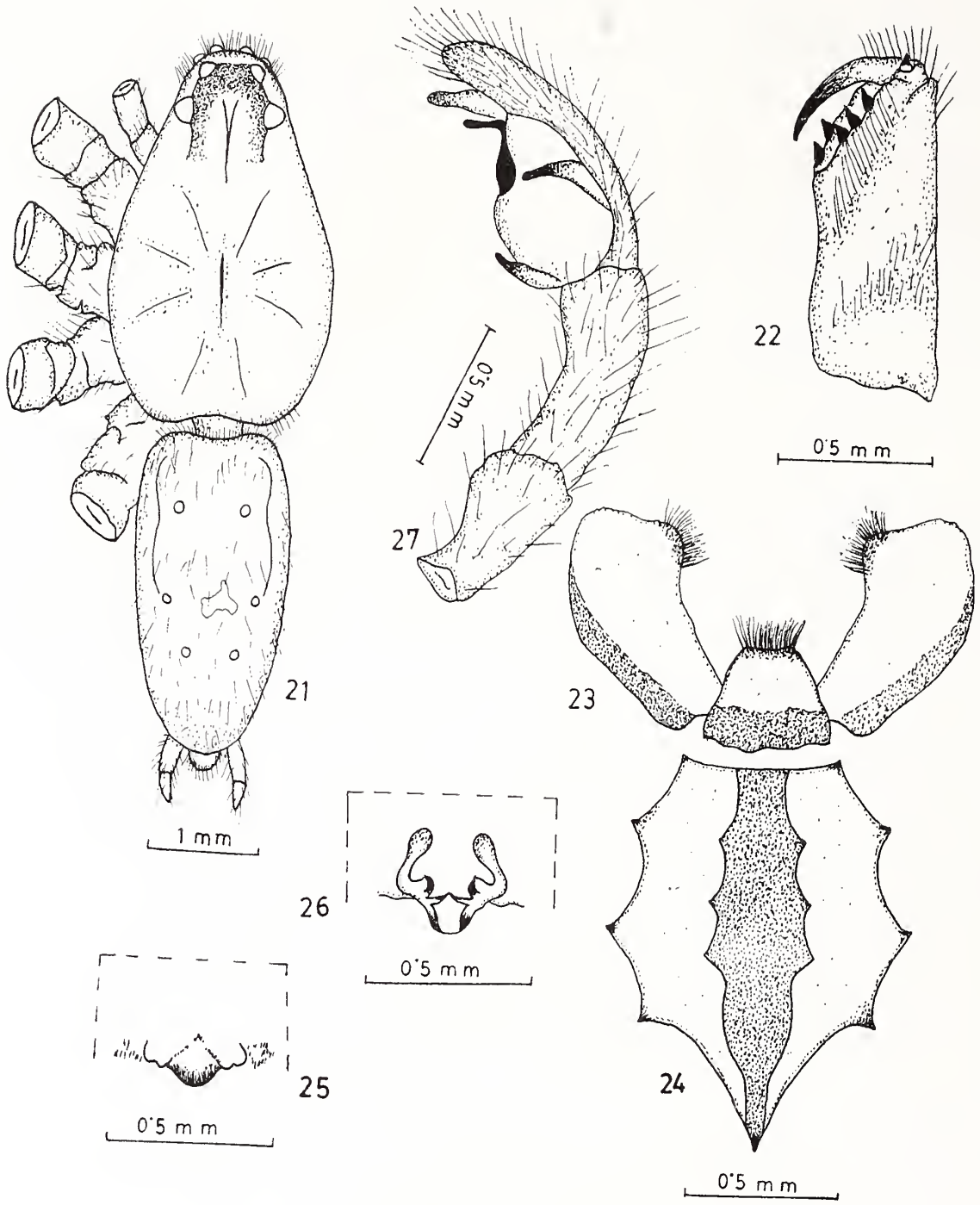
Distribution: Africa; Asia; Europe



Figs 15-20: *Hippasa partita* (Cambridge)
15. *H. partita* (dorsal view), 16. Chelicerae, 17. Maxillae and Labium, 18. Sternum, 19. Epigynum, 20. Internal genitalia

KEY TO THE SPECIES

1. Cephalothorax elongate, anteriorly narrowed (Fig. 21); 3rd row of eyes much larger and widely placed; abdominal dorsum with 3 pairs of small spots, otherwise not decorated; labium basally broad (Fig. 23) ..... *pisaurina*
— Cephalothorax never elongate; 3rd row of eyes similar to the 2nd row; abdominal dorsum never with such spots but always decorated; labium basally narrow 2
2. Sternum typically heart-shaped, devoid of any longitudinal band (Fig. 4); abdominal dorsum with 2 longitudinal posteriorly narrowing furrows interconnected by 3 transverse ones (Fig. 1); cheliceral outer margin with 2 teeth (Fig. 2) ..... *greenaliae*
— Sternum never as above, but always with a longitudinal band; abdominal dorsum never with any furrow; outer margin of chelicerae with 3 teeth 3



Figs 21-27: *Hippasa pisaurina* Pocock
21. *H. pisaurina* (dorsal view), 22. Chelicerae, 23. Maxillae and Labium, 24. Sternum, 25. Epigynum, 26. Internal genitalia, 27. Male palp

3. Epigyne tongue-like (Fig. 19); cephalic region constricted (Fig. 15); anterior row of eyes straight; maxillae basally flat and distally broad (Fig. 17); sternum broad anteriorly (Fig. 18) ..... *partita*

— Epigyne never as above (Fig. 12); cephalic region never constricted (Fig. 8); anterior row of eyes recurved; maxillae basally pointed, medially broad and anteriorly narrowing (Fig. 10); sternum broad below the middle (Fig. 11) ..... *holmarae*

***Hippasa greenaliae* (Blackwall)**
(Figs 1-7)

1867. *Lycosa greenaliae* Blackwall, Ann. Mag. Nat. Hist. 3 (19): 387.

Description: Colour: Cephalothorax dark brown; legs yellow brown and abdomen brown with white patches.

Measurements (Female): Total body length 7.00 mm. Carapace length 3.50 mm; carapace width 2.50 mm; abdominal length 3.50 mm; abdominal width 2.10 mm. (Male): Total body length 6.00 mm. Carapace length 2.40 mm; carapace width 2.00 mm; abdominal length 3.60 mm; abdominal width 1.80 mm.

Material examined: 1 ♀, Bagerhat, 12.vii.1991, Coll. V. Biswas; 2 ♀, 1 ♂, Faridpur, 18.v.1992, Coll. V. Biswas; 1 ♀, BARI, Jessore, 14.ix.1992, Coll. V. Biswas; 1 ♀, Pabna, 9.iv.1992, Coll. V. Biswas; 2 ♀. 1 ♂, Pirojpur, 12.vii.1992, Coll. V. Biswas; 2 ♀, Digha, Rajshahi, 3.iii.1992, Coll. V. Biswas.

Distribution: Bangladesh: Bagerhat, Faridpur, Jessore, Jhenidah, Pabna, Pirojpur, and Rajshahi; India; Sri Lanka (Tikader and Malhotra 1980).

Hippasa holmarae Thorell
(Figs 8-14)

1895. *Hippasa holmarae* Thorell, Spiders of Burma: 218.

Description: Colour: Cephalothorax golden yellow; legs yellow and abdomen gray. Measurements (Female): Total body length 7.00 mm. Carapace length 3.60 mm; carapace width 2.50 mm; abdominal length 3.40 mm; abdominal width 2.00 mm. (Male): Total body length 6.00 mm. Carapace length 2.50 mm; carapace width 2.00 mm; abdominal length 3.50 mm; abdominal width 1.80 mm.

Material examined: 3 ♀, Barisal, 18.ii.1991, Coll. V. Biswas; 2 ♀, Chandpur, Comilla, 12.v.1991, Coll. V. Biswas; 2 ♀, Potia, Chittagong, 12.iii.1992, Coll. V. Biswas; 3 ♀, S. Park, Dhaka, 4.v.1991, Coll. V. Biswas; 2 ♀, 1 ♂, Modhukhali, Faridpur, 12.v.1990, Coll. V. Biswas; 2 ♀, Nawapara, Jessore, 12.viii.1989, Coll. V. Biswas; 2 ♀, 1 ♂, Chalna, Khulna, 18.ix.1990, Coll. V. Biswas; 2 ♀, 1 ♂, Digha, Rajshahi, 4.iii.1992, Coll. V. Biswas; 2 ♀, BTRI, Srimongal, Sylhet, 18.x.1992, Coll. V. Biswas.

Distribution: Bangladesh: Barisal, Chittagong, Comilla, Dhaka, Faridpur, Jessore, Khulna, Pabna, Rajshahi, Sylhet; Burma; China; India; Singapore (Tikader and Malhotra 1980).

Hippasa partita (Cambridge)
(Figs 15-20)

1876. *Trochosa partita* Cambridge, Proc. Zool. Soc.: 541.

Description: Colour: Cephalothorax yellow-brown, legs yellow and abdomen blackish with few transverse whitish hairy bands. Measurements (Female): Total body length 8.00 mm. Carapace length 3.50 mm; carapace width 2.60 mm; abdominal length 4.50 mm; abdominal width 2.00 mm.

Material examined: 2 ♀, BRRI, Joydevpur, Gazipur, 15.ix.1992, Coll. V. Biswas; 2 ♀, Shikarpur, Jhenidah, 19.xi.1991, Coll. V. Biswas; 1 ♀, Arpara, Magura, 18.viii.1992, Coll. V. Biswas; 2 ♀, Teroshri, Manikganj, 11.ix.1992, Coll. V. Biswas; 2 ♀, RU Campus, Rajshahi, 3.iii.1992, Coll. V. Biswas; 3 ♀, Digha, Rajshahi, 4.iii.1992, Coll. V. Biswas.

Distribution: Bangladesh: Gazipur, Jhenidah, Magura, Manikganj, Rajshahi; Alexandria; Arabia; Central Asia; Egypt; India; Pakistan (Tikader and Malhotra 1980).

Hippasa pisaurina Pocock
(Figs 21-27)

1900. *Hippasa pisaurina* Pocock, Fauna Brit. India, Arach.: 250.

Description: Colour: Cephalothorax yellow; legs yellow-brown and abdomen blackish. Measurements (Female): Total body length 10.30 mm. Carapace length 4.00 mm; carapace width 3.00 mm; abdominal length 6.30 mm; abdominal width 3.20 mm. (Male): Total body length 7.00 mm. Carapace length 2.50 mm; carapace width 1.90 mm; abdominal length 4.50 mm; abdominal width 2.00 mm.

Material examined: 2♀, Barisal, 11.iii.1992, Coll. V. Biswas; 2 ♀, S. Park, Dhaka, 18.x.1991, Coll. V. Biswas; 2 ♀, Shikarpur, Jhenidah, 8.ix.1989, Coll. V. Biswas; 2 ♀, 1 ♂, Daulatpur, Khulna, 12.v.1991, Coll. V. Biswas; 1 ♀, Teroshri, Manikganj, 28.v.1992, Coll. V. Biswas; 2 ♀, BAU, Mymenshingh, 18.v.1992, Coll. V. Biswas; 2 ♀, Pabna, 19.v.1991, Coll. V. Biswas; 3 ♀, Rajshahi, 4.iii.1992, Coll. V. Biswas; 1 ♀, Nagarpur, Tangail, 5.viii.1992, Coll. V. Biswas; 1 ♂, Kurigram, Rangpur, 11.iii.1992, Coll. V. Biswas.

Distribution: Bangladesh: Barisal, Dhaka, Faridpur, Jessore, Jhenidah, Khulna, Manikganj, Mymenshingh, Pabna, Rajshahi, Rangpur, Tangail; India; Pakistan (Tikader and Malhotra 1980).

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29. ADDITIONS TO THE GRASS GENERA OF NORTH-WEST RAJASTHAN[1]

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Intensive and extensive survey over the last seven years on the grass flora, Family Poaceae, of north-western Rajasthan (comprising ten districts of north-west Rajasthan, namely Barmer, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jodhpur, Nagaur, Sikar and Jhunjhunu) have yielded four unrecorded the grass genera from this region. Full description with distribution is provided for each genus in this paper. Voucher specimens have been deposited in the Herbarium of Laboratory of Ethnobotany and Agrostology, Department of Botany, College of Science, Udaipur, Rajasthan.

1. ***Arthraxon lancifolius*** (Trin.) Hochst. in Flora 39:188, 1856; Fischer in Fl. Mad. 3: 1729, 1934; Blatter and McCann Bomb. Grass. 77, 1935. Bor in Fl. Assam 5:378, 1940. Rhind, Grass, Burma 69, 1945; Raizada in Ind. For. Rec. 4:101, 1954; *Andropogon lancifolius* Trin. in. Mem. Acad. Petersb. 6 ser 2:271, 1832; *Arthraxon microphyllus* Hochst. in Flora 39:188, 1856; Hook.f. Fl. Brit. Ind. 7:147, 1996; Haines, Bot. Bih. and Ori. 2:1026, 1924.

An annual. Culms 10-40 cm tall. Leaves lanceolate. Inflorescence: common axis very slender. Sessile spikelets: 2.5-3.5 mm long, straight, linear-lanceolate, almost compressed laterally. Lower glume 3 mm long.

Ecology: A grass of damp habitats, growing in colonies, between rocks on walls of houses.

Fl. & Fr.: August-October

Locality: Jhunjhunu

IC number: 255256 (given by NBPGR, New Delhi)

Specimen examined: Takhar, 221

2. ***Arundo donax*** Linn. sp. Pl. loc. cit. FBI 7:302, 1896; Cook in FPB 3: 574, 1958; Bor in GBCIP 413, f. 44, 1960.

A perennial grass. Culms creeping below, finally erect, 1-6 m tall, hollow many-noded, green, simple or sparingly branched, terete, smooth and glabrous. Inflorescence a large, terminal, decompound, pulmose panicle. Grains 2.5 mm long.

Fl. & Fr.: August-October

Ecology: This stout reed grows in dry habitats when established, but it prefers plenty of moisture. As a fodder grass it is not of much account, but cattle will browse upon the young leaves.

Locality: Ranoli, Sikar and Jodhpur

IC number: 255341 (given by NBPGR, New Delhi)

Specimen examined: Takhar, 314

3. ***Avena sativa*** Linn. sp. Pl. ed. 1:79, 1753; Cook in FPB 3:574; 1958; Bor in GBCIP; 434; 1960.

An annual. Culms simple. Spikelets 22-30 mm long or longer usually with a 1-awned floret at the base and one or two awnless floret above or with all the florets awnless. Grain tightly enclosed by the lemma and palea free silky all over.

Fl. & Fr.: December- February

Ecology: Commonly found in cultivated field of wheat.

Locality: Throughout the study area.

Specimen examined: Takhar, 312

4. ***Bothriochloa intermedia*** (R. Br.) A Camus in *Ann. Soc. Linn.* Lyon, 1930, n.s. 76,164, 1931; Bor in GBCIP 108, 1960.

Perennials, culms tufted. Inflorescence 10-20 cm long. Glumes equal, the lower hairs pitted or not.

Fl. & Fr.: August-October

Ecology: Found growing occasionally in the grasslands on hillocks

Locality: Harshnath, Sikar

Specimen examined: Takhar, 223.

ACKNOWLEDGEMENTS

We are thankful to the Indian Council of Agricultural Research (ICAR), New Delhi for financial assistance, Forest Research Institute, Dehradun and Botanical Survey of India, Jodhpur for herbarium identification.

30. *PONERORCHIS NANA* (KING & PANTL.) SOO (ORCHIDACEAE): A NEW RECORD FOR UTTARAKHAND[1]

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Deva and Naithani (1986) provided the taxonomic account of all known species of orchids from north-west Himalaya and described nearly 239 species, based on the study of herbarium specimens and published records. They reported *Ponerorchis nana* (King & Pantl.) Soo from Himachal Pradesh based on the collections made by B.S. Aswal from Rohtang in Lahul, growing between 3,000-4,000 m altitude. This species was earlier described in India from Sikkim Himalaya by King and Pantling (1898) as *Orchis chusua* var. *nana* King & Pantl. There has been no collection of this species from any part of Uttarakhand till date. During a recent orchid exploration in Uttarakhand, *P. nana* was collected from an alpine zone of Uttarkashi district, Garhwal Himalaya for the first time. The collection of this species from Garhwal forms an interesting addition to the orchid flora of Uttarakhand.

In this note, a brief description along with a note on the flowering period, ecology and distribution of the species is given. Field number along with the collector's name is given in parenthesis. The voucher specimens are deposited in the herbarium, Wildlife Institute of India (WII), Dehradun.

Ponerorchis nana (King & Pantl.) Soo, Acta Bot. Acad. Sci. Hung. 12: 353 (1906); Deva & Naithani, Orchid Fl. North West Him. 199. t. 106 (1986). *Orchis chusua* var. *nana* King & Pantl., Ann. Roy. Bot. Gard. 8: 303. t. 402A (1898). *O. nana* (King & Pantl.) Schltr. in Feddes Repert. 9: 434 (1911). *Chusua roborowskyi* var. *nana* (King & Pantl.) P.F. Hunt, Kew Bull. 26: 1876 (1971). *C. nana* (King & Pantl.) Pradhan, Indian Orchid 2: 678 (1978).

Terrestrial, up to 10 cm long with oblong, bilobed tuber; stem with one or two blunt tubular sheaths at the base; leaf one, linear-lanceolate, acute or acuminate, grooved; inflorescence single-flowered; flowers white or purple; bracts lanceolate, acuminate, equalling the ovary; sepals spreading; petals ovoid; lip shallowly 3-lobed with broad truncate apex and crenate margin; spur cylindrical as long as the ovary, somewhat compressed.

Fl.: July-August.

Ecology: Rare ground orchid that prefers to grow in grassy slopes and meadows at *c.* 3,600 m.

Specimens examined: INDIA: Garhwal: Uttarkashi in Chuli Bugyal (G.S. Rawat 14781 WII).

Distribution: INDIA (Uttarakhand-Garhwal; Himachal Pradesh, Sikkim); Nepal.

ACKNOWLEDGEMENT

We thank the Director of Wildlife Institute of India (WII), Dehradun for facilities and encouragement.

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31. A NOTE ON THE OCCURRENCE OF *LISTERA TENUIS* LINDL. (ORCHIDACEAE) IN KUMAON HIMALAYA[1]

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Deva and Naithani (1986), while describing the orchid flora of the north-west Himalaya, reported *Listera tenuis* Lindl. from Uttarakhand. While this species has been collected from subalpine and alpine areas of Chamoli district in Garhwal Himalaya, their report of this species from Kumaon Himalaya is based on a specimen reported to have been collected from Thal in district Pithoragarh, at an altitude of about 1,000 m. Other than this there are no other collections of this species from Kumaon Himalaya in the Indian Herbaria. As all the species of this genus grow at higher elevations, i.e., between 2,100 and 4,000 m, in north-west Himalaya, Deva and Naithani (1986) doubted the occurrence of this species at lower altitudes, and suggested further collections of this species to confirm its occurrence in Kumaon Himalaya. The same comment was repeated by Pangtey *et al.* (1991) due to non-availability of any collection of this species from Kumaon Himalaya.

During the course of an orchid exploration in Uttarakhand, a few specimens of this orchid were collected from upper Gori valley in Kumaon Himalaya. In this note we confirm the occurrence of this species at higher altitudes of Kumaon Himalaya along with a brief note on its habitat. It can be stated that the earlier collection of this species from Thal may be erroneous. Voucher specimens are deposited in the herbarium, Wildlife Institute of India (WII), Dehradun.

Ecology: A rare ground orchid usually in the subalpine and alpine areas among shrubs. Only 4-5 individuals were seen under *Rhododendron campanulatum* near Tola village (3,500 m) in the upper Gori valley.

Specimen examined: Kumaon: Pithoragarh district in upper Gori valley J.S. Jalal 13945, WII.

Distribution: INDIA (Garhwal, Kumaon, Sikkim, Arunachal Pradesh), Nepal, Tibet.

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We thank the Director of Wildlife Institute of India (WII), Dehradun for facilities provided.

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32. *SYNOTIS ALATUS* (WALL. EX DC.) JEFFERY (ASTERACEAE) – A NEW RECORD FOR ARUNACHAL PRADESH[1]

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The genus *Synotis* has about five species, which are found mostly in the eastern and western Himalaya (Hooker 1981). This information is based on a survey and collection of plant material by the author and through consultation with the herbarium, Botanical Survey of India northern circle, Dehradun. During 2001, while conducting a survey and collection of medicinal plants growing in the Bomdila and Twang districts of Arunachal Pradesh, I came across a plant

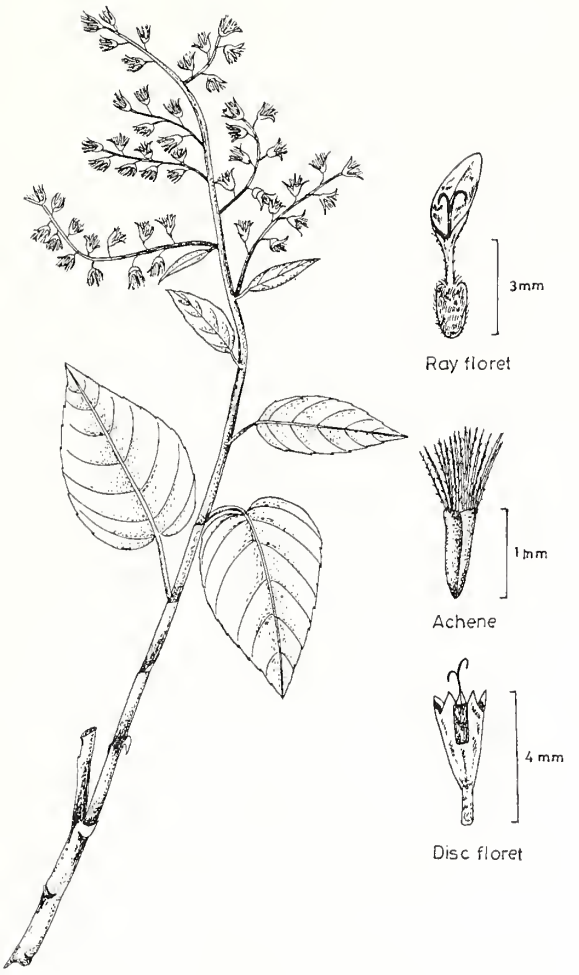

Fig 1: *Synotis alatus* (Wall. ex DC.) Jeffrey

at Twang near the forest road. Upon consulting literature, I found that the species *Synotis alatus* had neither been reported nor collected from this region to date (Kanjilal *et al.* 1934-1940; Hajra *et al.* 1995). Hence, this is a new record for the state of Arunachal Pradesh.

The description along with a line diagram (Fig. 1) of its, habit, habitat, flowering and fruiting time, and distribution of the taxon in India have been elaborated.

Synotis alatus: (Wall. ex DC.) Jeffery & Chen, Y.L. in Kew Bull. 39 (2): 308. 1984. (Asteraceae); Hajra *et al.* Fl. of India 13: 287, 1995. *Senerio alatus* Wall. ex DC.; Hook. f., Fl. Brit. India 3: 353, 1881.

A perennial grey tomentose rhizomatous herb, up to 80 cm long, stout, rhizome woody. Leaves subrosulate, ovate-oblong, sessile, acute-acuminate, base sub-auriculate, 12-19x7-9cm, hairy beneath, uppermost leaves smaller in size at base, sessile. Head yellow, inconspicuously radiate, *c.* 5-7 cm long, involucre cylindrical, densely hairy; bracts 5-7, linear-lanceolate, 7x1 mm. Ray florets 2-3, 2-3 mm long, unequal, shorter than styles; disc florets *c.* 4 mm long. Achenes greyish, *c.* 1 mm long, pubescent; pappus of pale, scarbids hairs, *c.* 4.5 mm long.

Specimens examined: Twang forest Arunachal Pradesh. Field no. CIMAP, 10825.

Fl. & Fr.: October-December.

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I thank Dr. S.P.S. Khanuja, Director, Central Institute of Medicinal and Aromatic Plants, Lucknow for providing all facilities during the survey. I feel obliged to Dr. D.K. Singh and Mrs. A. Mathur, Botanical Survey of India, Northern Circle, Dehradun for confirming the identity of the plant.

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33. *HERNIARIA CINEREA* DC. (CARYOPHYLLACEAE) – A NEW RECORD FOR INDIA[1]

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Genus *Herniaria* L., with 48 species (Mabberley 1997), is distributed mainly in Europe, Africa and Central Asia. Its eastward distribution is up to India, whereas westward it extends up to South America. In India, the genus is represented by three species, namely *H. hirsuta* L., *H. incana* Lam. and *H. cachemiriana* Gay, distributed mainly in northern India

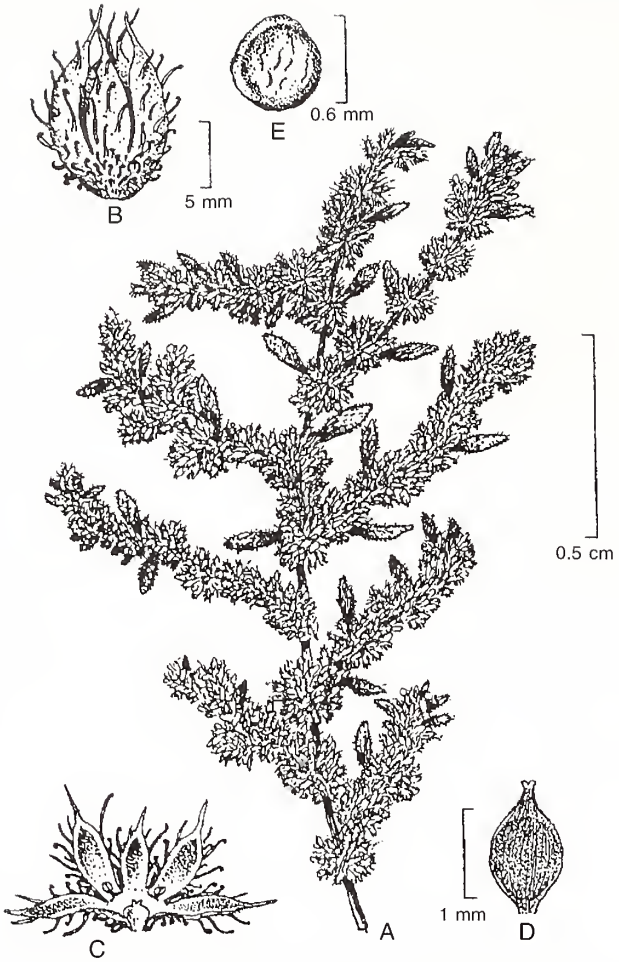

Fig. 1: *Herniaria cinerea* DC. (A-E): A. Habit; B. Flower; C. Dissected flower showing stamens and gynoecium; D. Fruit; E. Seed

(Majumdar 1993). Critical studies on the material of the genus housed in the herbarium of Botanical Survey of India, Dehradun (BSI) and perusal of relevant literature (Hooker 1885; Ghafoor 1973; Majumdar 1993) revealed the occurrence of a fourth representative of the genus, *H. cinerea* DC., hitherto unknown in India, thus extending its range of distribution further eastward. The species is described and illustrated as a new record for India, to facilitate its easy identification..

Herniaria cinerea DC., Fl. Fr. Suppl. 6: 375. 1815 (Caryophyllaceae) (Fig. 1)

Prostrate, hirsute herbs, 8-10 cm long, with spreading branches. Leaves alternate to more or less opposite, sessile; lamina narrowly elliptic to elliptic - oblanceolate, 3-6 mm long, 0.8-1.5 mm wide, apex acute, margins entire, surfaces hirsute; stipules minute, membranous, margins ciliate. Flowers 5-12, in densely clustered pseudoaxillary cymes, bracteate; bracts minute. Flowers sessile pentamerous, yellowish green. Sepals 5, free, unequal; outer 2 comparatively longer, oblong, 1.5-2.1 mm long, obtuse, with non-membranous margins; inner three lanceolate, 1.5-1.9 mm long; outer surface in upper part covered with short or long, stiff, straight hairs mixed with uncinate hairs, perigynous zone externally densely covered with uncinate hairs. Petals 5, rudimentary, free, setaceous, alternating with sepals. Stamens 2, opposite to longer sepals, free; filaments minute; anthers oblong. Styles minute, bi-lobed; lobes shortly divergent. Fruits ovate, 1.4-2.1 mm long, with membranous pericarp, almost equal to or enclosed by calyx. Seeds subglobose, 0.6-0.75 mm in diameter, brown to brownish black.

Fl. & Fr.: February-March.

Specimen examined: INDIA: Haryana, Fatehabad, 16.ii.1963, N.C. Nair 26009 (BSI). Rare.

Distribution: INDIA: Haryana; Europe, Africa, Central Asia, Pakistan.

H. cinerea DC. can be easily distinguished from other Indian species of the genus in the presence of 5 unequal sepals (2 outer long, 3 inner short), with non-membranous margins and perigynous zone externally densely covered with uncinate hairs; stamens 2, situated opposite outer sepals.

While Hooker (1885) and Ghafoor (1973) have treated the genus under Family Illecebraceae, Majumdar (1993), following the family delimitation proposed by Cronquist (1981), has included the Family Illecebraceae under Family Caryophyllaceae. The same has been followed by Mabberley (1997).

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34. A NOTE ON DISTRIBUTIONAL RECORD OF *SPERGULARIA DIANDRA* (GUSS.) HELDR. & SART FROM PIN VALLEY NATIONAL PARK IN INDIA[1]

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Pin Valley National Park (PVNP) is situated between 31° 61' 40" to 32° 21' 20" N and 77° 4' 21" to 78° 6' 19" E. The Park is located in the cold desert area of Spiti sub-division in Lahaul-Spiti district, Himachal Pradesh. During a recent survey, July 15, 2002, and exploration of plant resources of this Park, few interesting specimens of *Spergularia* (Pers.) J. & C. Presl growing along with *Caragana versicolor* Benth., on rocky slopes, at an altitude of *c.* 4,100 m have been collected. Detailed study of literature and critical examination of the specimens reveals that they belong to *Spergularia diandra* (Guss.) Heldr. & Sart, hitherto known from Farrukhabad district in Uttar Pradesh, and other parts of Asia and Europe. It is now being reported from PVNP, Himachal Pradesh, for the first time. An expert opinion has also been sought regarding its identity from Dr. Shahina Ghazanfar, who has worked on Caryophyllaceae in Pakistan.

The genus *Spergularia* (Pers.) J. & C. Presl comprises of 25 species, which are cosmopolitan in distribution (Mabberley 1998). Majumdar (1993) reported only one species *Spergularia rubra* (L.) J. & C. Presl growing as a weed in plains and hilly regions of Haryana, Jammu & Kashmir and Uttarakhand. Naithani and Dayal (1981) reported *Spergularia diandra* (Guss.) Heldr. & Sart from Farrukhabad district of Uttar Pradesh in the Gangetic plain in 1968. The same species was not included in 'Flora of India' (Caryophyllaceae) by Majumdar (1993).

Hence, the report of *Spergularia diandra* (Guss.) Heldr. & Sart from Pin Valley National Park, Lahaul-Spiti in Himachal Pradesh shows an extended distribution of the taxon from the Gangetic plains to alpine Himalaya, and constitutes an addition to the flora of Himachal Pradesh. Besides, the species has also been collected after a lapse of more than three decades.

The taxonomic citation, brief description, phenology, ecology, distribution, specimens examined and illustration have been provided to facilitate an easy identification of the species in the field.

Spergularia diandra (Guss.) Heldr. & Sart in Herb. Grace. Norm. 492: 1124, 1855; Naithani & Dayal in *Indian J. Forestry 4(3)*: 242, 1981; Ghazanfar & Nasir in Nasir & Ali, Fl. W. Pakistan 175: 51, 1986. *Arenaria diandra* Guss., Prod. Soc. 1: 515, 1827. Fig. 1.

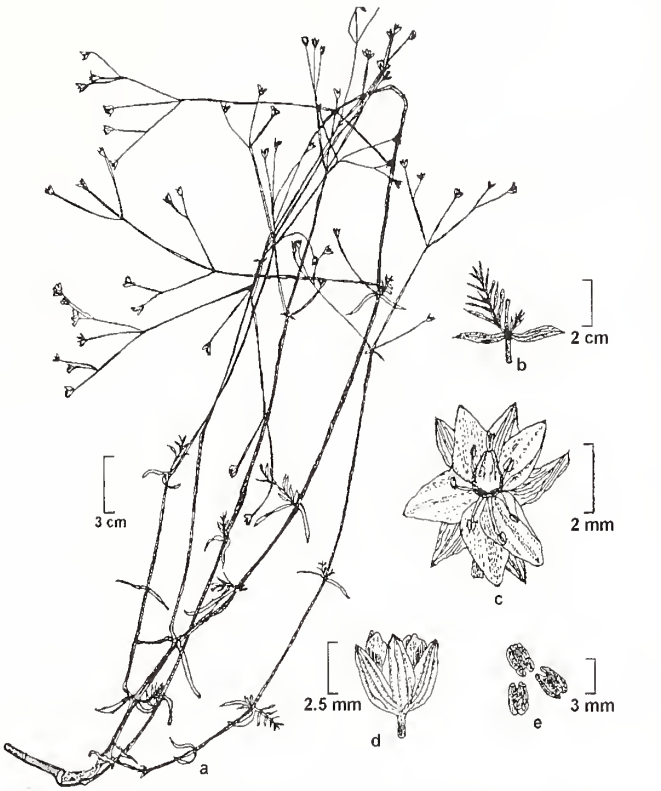

Fig. 1: *Spergularia diandra* (Guss.) Heldr. & Sart: a. Habit, b. Node, c. Flower, d. Capsule enclosed in calyx, e. seeds

Perennial herbs, woody at base. Stems decumbent, often ascending, up to 70 cm high, glabrous. Leaves opposite, 2.1-3 x 0.9-1.3 cm, fascicled, mostly on one side of node; leaflets sessile, linear-narrowly lanceolate, 1.1-1.3 x 0.1-0.2 cm, acute, glabrous fleshy. Stipules prominent, linear-narrowly lanceolate, 1.4-2.6 x 0.2-0.35 cm, base united around the node, acute, glabrous. Flowers in cymes 15-21 cm long; bracts linear, 0.8-1.1 x 0.1-0.2 cm, acute. Sepals 5, free, ovate-lanceolate, 3-4 mm long, glabrous. Petals 5, ovate, equal or slightly shorter than sepals, entire, white. Stamens 5-8. Styles 3. Capsules ovoid, as long as sepals, 3-valved. Seeds 2-4, 2.5-3 x 2-2.5 mm, tuberculate, unwinged, brown.

Fl. & Fr.: July-September.

Distribution: INDIA: Himachal Pradesh (Lahaul-Spiti), Uttar Pradesh; China; Kazakhstan; Pakistan; USSR; Europe; Iran and Iraq.

Ecology: Rare. Growing along with *Caragana versicolor* Benth. at an altitude of *c.* 4,100 m.

Specimens examined: Uttar Pradesh, Farrukhabad, Mahmoodpur Sinauda (Tilia Garho), March 04, 1968, Ram Dayal 1968 T (DD); Himachal Pradesh, Lahaul-Spiti, Pin Valley National Park, Gechang-Thango, *c.* 4,100 m, July 15, 2002, K. Chandra Sekar 100450 (BSD, K).

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35. A NOTE ON THE IDENTITY AND RANGE EXTENSION OF *RICCIA GROLLEI* UDAR[1]

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During the survey of bryophytes in and around the National Thermal Power Corporation, Unchahar in the Raebareli district of Uttar Pradesh, we collected and identified a species *Riccia grollei* Udar, which was the only liverwort growing in the pollution stressed environment of Unchahar. The species has extended its distribution from southern India, central India and Rajasthan to the Gangetic Plains of northern India (Parihar *et al.* 1994). It was first reported by Pande and Udar (1958) from southern India, and was named *Riccia tuberculata* Pande *et* Udar, but was later found to be a homonym of *Riccia tuberculata* Lamarck *et* Poiret. Hence, Udar (1965) adopted a new name, i.e. *Riccia grollei* Udar.

The diagnostic feature of the species is the presence of tuberculate thickening on a few cells of photosynthetic filaments. The tendency to synthesize food is thought to be great in this species, as the chloroplasts are not confined to the photosynthetic zone, but can also be seen in the cells of the storage zone. In the specimens collected from the vicinity of the NTPC, Unchahar, Raebareli, the spores do not possess the tri-radiate mark and wing, which were present on the specimens reported by Udar from southern India. A brief note on the identity and occurrence of this species is given below:

Riccia grollei Udar Curr. Sci. 34: 126 (1965)

Plants 0.2-0.5 cm long, 0.2-0.3 cm wide, green, mono or bifurcate overlapping, apex rounded, fingerprint-like impression on the dorsal surface of thallus; rhizoids brown, both type simple and tuberculate in ratio 9-12: 6-10 in each transverse section of thallus; scales feebly developed, light brown; photosynthetic filament 220 µm long, 5-8 cells in one filament, hyaline cell 39-40 µm, filaments very compact with characteristic tuberculate thickening very prominent on cells of some filaments; air pore simple 10-12 µm; chloroplasts numerous in green cells of photosynthetic filaments and in storage zone; neck of archegonia 130 µm, venter 80 µm; young spores yellowish brown, mature dark brown, 81-90 µm along diameter; isopolar, reticulate, 4-6 angled, tri-radiate mark absent, 07-08 reticulations along diameter, size of one reticulation 10-14 µm, wings absent.

Specimen examined: ERC 3/2002 Coll & Det.: Adarsh Kumar and Shazia Kazmi.

Location: Village Kaithaul, *ca* 5 km south of the National Thermal Power Corporation, Unchahar, Raebareli district, Uttar Pradesh; 16.viii.2002.

Distribution: India: Runnymede, Madras State, southern India; central India; Rajasthan.

Remarks: Very rare, found sporadically on cemented walls.

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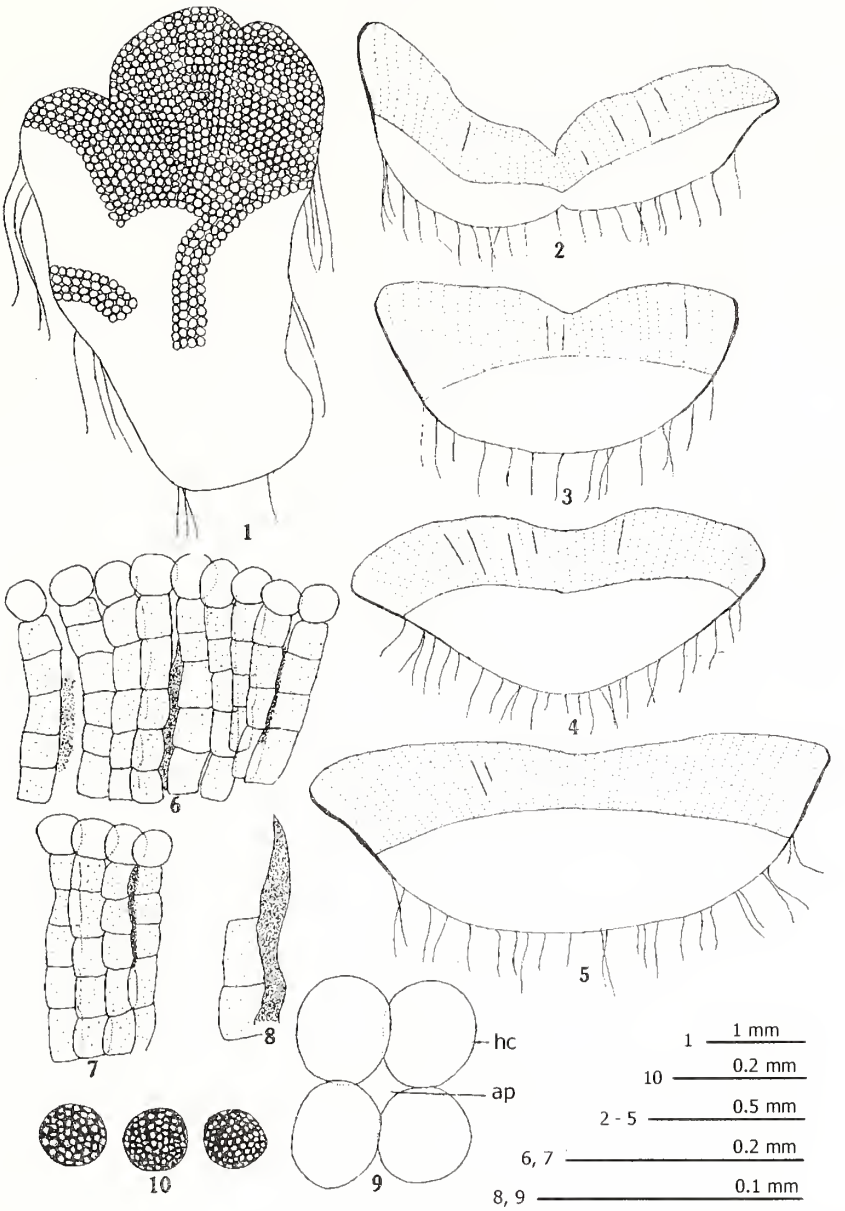

Figs. 1-10: *Riccia grollei* Udar: 1: Thallus, dorsal; 2-5: T.S. of thallus at the apex, behind the apex, in the middle and at the base respectively; 6-7: Photosynthetic filament showing characteristic tubercular thickenings; 8. Enlarged portion of thickening; 9. Hyaline cells (hc) showing airpore (ap); 10. Spores, showing reticulations

Botany, University of Lucknow, for confirming the identification of the plant specimen. We are also grateful to the Head, Department of Botany, and the Principal, Feroze Gandhi College, Raebareli for laboratory facilities.

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